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State Departments of Transportation (DOTs) are the primary owners of roadway infrastructure in the United States. Many of the employees of state DOTs work on roadway work sites, putting them at disproportionately higher risks of injury or fatality. A review of the literature determined that a combination of policies, standards, and data can be used to potentially reduce these risks. Understanding current practices at state DOTs for promoting and documenting the safety of their employees is critical to understanding successes and deficiencies to improve resource allocation. To determine the state of the practice, a survey of state DOT practices followed-by state DOT safety program case studies were conducted. The results confirmed that state DOTs are diverse agencies that have different scopes and priorities. The survey results provided evidence of this diversity from how incidents are recorded and archived to how data is collected and used at each agency. The case studies demonstrated a variety of safety programs that use various levels of data in the processes of program development and evaluation. Overall, data is not well integrated into state DOT safety programs and there is significant opportunity to expand the ways in which data is used to reduce risk to highway workers.

A Review of Current State Department of Transportation Practice for Promoting and Documenting the Safety of Field Employees

by
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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Zachary Wesley Barlow, Author

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1 INTRODUCTION

1.1 Problem Statement Summary and Scope

Every year in the United States, employees of state DOTs are killed and injured while at work in highway work sites. These highway worker injuries and fatalities are sad consequences of the high risks associated with working in active construction and maintenance work sites and on roadways near active traffic ways. One of the objectives of state DOTs is to maintain effective safety programs and policies that minimize the safety risk to their workers and to the general public in highway work sites. Health and safety data is often available to the state DOTs to aid in the development of effective work site safety management techniques.

Each state DOT is a unique agency. While they perform the similar function of owning, designing, constructing, operating, and maintaining elements of their state's transportation infrastructure, they are structured differently and, as a result, have different responsibilities to their employees and the citizens of their state. To cover the full breadth of issues faced by the diverse set of state DOTs, this Thesis focuses on state DOT employees working in work sites on any roadway. In most cases, these roadways are the primary highways of the state, while in others they include local and county roads as well. This variety of functionally classed roadway environments produces various levels of risk for the state DOT employees in work sites on roadways.

State DOTs are at various stages of leveraging available data to reduce the risk to their workers in work sites. The volume of information, particularly that available in current literature and in the details of state programs based upon data driven policies, is limited due to the relative novelty of this area of research

and practice. The Federal Highway Administration (FHWA) has made the use of data for decision making a policy priority. One demonstration of this policy is the requirement that projects for the Highway Safety Improvement Program (HSIP) must be selected through data-driven decision making. The HSIP is a program element of the Fixing America's Surface Transportation (FAST) Act, signed into law in 2015 (FHWA 2016c). Data driven programs have the potential to improve safety of employees, but data is not the entire solution. Data should be used as an element of a larger safety program that focus on the employees involved.

The purpose of this research study is to provide a current state of the practice review for state DOT health and safety policies, and determine how the policies are implemented to help protect highway workers performing their duties in work sites. While the study focuses on specifically safety policies, it explores both the current health and safety practices in state DOTs and describes the practices predominantly in terms of nationwide trends. Based on the findings of existing practice, the study identifies gaps in knowledge and high value areas of future research.

1.2 Terminology

Several terms used throughout the Thesis require definitions specific to the context of this research. These terms, and their definitions for the purpose of this Thesis, are defined as follows:

- Incident: Any disruption in the normal flow of work involving a highway worker employed by a state DOT in a construction or maintenance site that involves an injury, fatality, property loss, damaged equipment, work stoppage, or near miss (Hinze 2006).

- Accident: An unplanned event that may or may not be associated with property damage, an injury, or a fatality (Hinze 2006). This term will not be used in this Thesis, unless it appears in a quote from a source or the literature reviewed specifically uses the word in its terminology. The word "incident" will be used throughout the Thesis to ensure clarity of meaning.
- Crash: A specific type of incident involving a public vehicle. This term is not used in the Thesis unless the literature reviewed or data analyzed specifically used this term for the incident that occurred.
- Work site: Any location where construction or maintenance work is being done on state DOT right-of-way.
- Work zone: A particular type of work site, generally in place for extended periods with established traffic control. This term appears in the Thesis when the literature reviewed or the data analyzed specifically used this term in their description. Otherwise, the more general term of work site, inclusive of a broader range of maintenance activities, was used.
- Near miss (near hit): An incident involving a highway worker employed by a state DOT in a construction or maintenance work site that did not result in an injury or fatality to the worker.
- Highway worker: An employee of a state DOT who is active in construction or maintenance work sites on state DOT right-of-way. Many of these workers are on foot within the work site. For the purpose of this Thesis, this definition does not include employees of consultants and contractors working on state owned projects. While this definition focuses on state DOT employees, local agency employees who are active in construction or maintenance work sites may experience a similar context

to that of state employees, so the presented concepts and ideas related to highway workers in this Thesis may also be of value to local agencies.

- Industry/Construction industry/Maintenance industry: When the term "industry" appears in the Thesis, unless otherwise stated, it is in reference to the broader construction and maintenance industry. It is not limited to simply construction or maintenance in highway work sites.
- Survey: The full process of developing, distributing, collecting, and analyzing data from targeted participants at state DOTs.
- Questionnaire: This term, which is commonly used in conjunction with the survey (e.g., survey questionnaire), refers to the data collection instrument containing the actual questions that were electronically distributed to the state DOTs to collect data regarding state DOT health and safety policies and practices.
- Participant: Any state DOT safety representative that was provided access to the survey questionnaire.
- Respondent: A participant in the survey process that completed the questionnaire regarding their state DOTs health and safety policies and practices.

The definitions of these terms, which are used in various chapters in this Thesis , are necessary to accurately convey the author's intentions and limit misinterpretation of the results synthesized.

1.3 Thesis Organization

This Thesis is organized into the following chapters to describe the various parts of the research and data collection:

- Chapter 2 – Literature Review

  This chapter explores current literature related issues and research related to highway worker safety. Particular focus is given to issues that specifically relate to state DOTs such as legal standards and policy as well as available sources of data for use by the agencies.

- Chapter 3 – Methods

  This chapter outlines the research questions that were developed to provide an overview of state DOT safety practice. In addition, this chapter outlines the methodology used to collect the data needed to answer the research questions.

- Chapter 4 – Survey Results

  This chapter is provides the results from the survey questionnaire which describes basic characteristics of the current practice of health and safety programs in state DOTs.

- Chapter 5 – State DOT Case Studies

  To highlight specific practices used by state DOTs, this chapter provides detailed findings on safety programs that have been implemented in seven state DOTs. The data was collected from follow-up interviews with state safety officials. The cases studies specifically analyze how data is used in the development and implementation of safety program elements.

Following the presentation of the research findings in these chapters, Chapter 6 presents a discussion of the findings in terms of the proposed research questions. Appendices containing documents such as the survey questionnaire and the interview protocol guide are included at the end of the Thesis.

2 LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the overarching issues related to highway worker safety. The information serves as background knowledge for the concepts and terminology needed in subsequent chapters and for understanding the knowledge and concerns associated with worker safety that are needed to effectively develop highway worker safety management programs. It also serves as a basis for the development of the research questions for this Thesis. The following sections are based primarily on a review of the literature regarding the topics of worker safety and work site safety in the United States. Focusing on the United States gives the information more relevancy to state DOTs that are subject to the same federal guidelines such as OSHA or their OSHA approved State Plan alternatives. Particular emphasis is placed on the following content areas:

- Prevalence and causality of injury and fatality incidents for highway workers
- Legal standards and policy recommendations related to highway workers
- Availability of highway worker safety data

These content areas highlight contemporary safety issues associated with highway workers at state DOTs and expose how the issues are currently being addressed through research and practice, and by national and state government policy.

2.2 Prevalence and Causality of Highway Worker Incidents

One of the best ways to improve safety programs and reduce highway worker injuries and fatalities is to understand the causes and frequency of incidents

associated with highway workers. Highway work sites potentially pose significant risk to motorists and workers which, if not effectively controlled, can lead to injuries and fatalities for both motorists and workers. Research has been conducted regarding specific types of work site incidents, comparing work site incidents to non-work site incidents, and possible methods to eliminate or reduce incidents that lead to injuries and fatalities.

Some states have also performed research to explore the causes and characteristics of work site crashes within their state. One study investigated crashes that occurred in Kansas work zones to better understand the characteristics of the crashes (Li and Bai 2007). The characteristics included demographic data like age and gender, and other characteristics relating to the incident like day of the week and environmental factors. The researchers compared these characteristics between fatal and non-fatal work zone incidents. By determining the different characteristics that may be linked to severity, researchers argued that this comparison could provide improved guidance regarding how and where crash reduction strategies could be implemented to maximize their effect (Li and Bai 2007).

A 2009 study involving states from the Smart Work Zone Deployment Initiative (SWZDI) sought to determine the characteristics of work zone crashes in Iowa, Kansas, Missouri, Nebraska, and Wisconsin (Dissanayake and Akepati 2009). These characteristics included incident frequency information based on light and weather conditions, as well as frequency information based on speed, driver behavior, and traffic control factors. The Thesis presents the similarities and differences between work zone incidents in the five states. For these states, only slight differences between the incident characteristics were found (Dissanayake and Akepati 2009). This result is possible because all of these states are located in

the Midwest region of the United States and are likely to have similar driver demographics, roadway conditions, and physical geography.

An Indiana DOT report (Ferreira-Diaz et al. 2009) identified two primary causes of worker fatalities in work zones. The first is when workers are struck by passing motorists and the second is when workers are struck by moving equipment within the work zone. The study determined that the causes of these types of incidents were primarily the result of "negligence of a third party" and "lack of awareness from the injured worker" (Ferreira-Diaz et al. 2009). Causes of work zone incidents are varied; however, the presence of high risk objects like fast-moving vehicles and large pieces of equipment present the greatest risk to highway workers. Lack of awareness from the injured worker is perhaps a cause that can be effectively mitigated through a highway worker safety program that includes worker training, internal traffic control plans, a focus on worker behavior, and improving safety culture.

While highway work sites are a specific and unique form of construction and maintenance site, they retain many of the same characteristics as other construction and maintenance sites. Therefore, it is also necessary to understand the prevalence and causality of incidents in all places where construction and maintenance work is carried out. In his dissertation, Hallowell (2008) summarized construction and maintenance incident causation and analytic models for those incidents. He described five models of incident causation complexity, including the distractions theory, goals-freedom-alertness theory, adjustment stress theory, two-factor theory (unsafe acts and unsafe conditions), and the Swiss cheese model of incident causation. Hallowell also indicates, however, that safety program elements that are physically implemented in organizations and work sites often lack connections to specific models of incident

causation. That is, to be effective, safety programs should take into consideration the established models of incident causation and target eliminating those behaviors, conditions, and operations that are shown to lead to incidents. Lacking such a connection, a safety program will not necessarily lead to improved safety.

The Construction Chart Book published by The Center for Construction Research and Training, is a synthesis of data relating to all aspects of the construction and maintenance industry. It is a publication with visual representations of construction industry statistics, provides simple and easy to comprehend descriptions of industry data. In this format, the data is summarized and presented in figures and tables. Figures 2.1 and 2.2 are example figures taken directly from The Construction Chart Book and show how injuries and fatalities are distributed by cause in the construction industry (CPWR 2013).

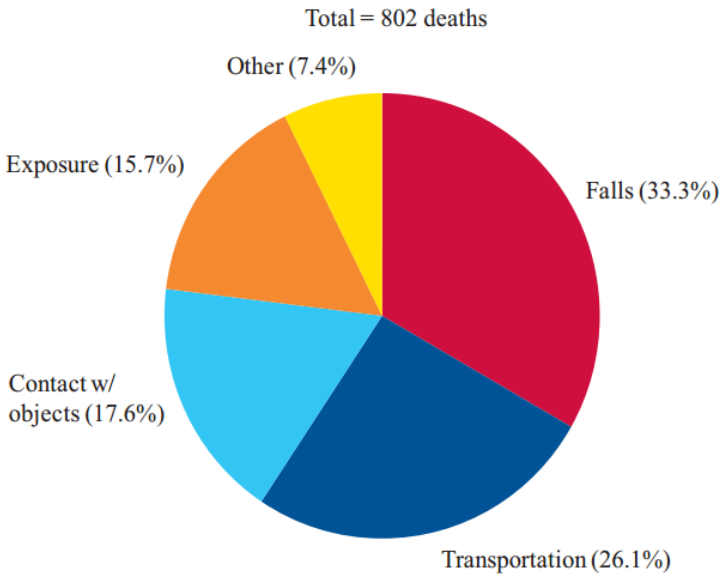

Figure 2.1 Distribution of leading causes of fatalities in construction, 2010 (CPWR 2013)

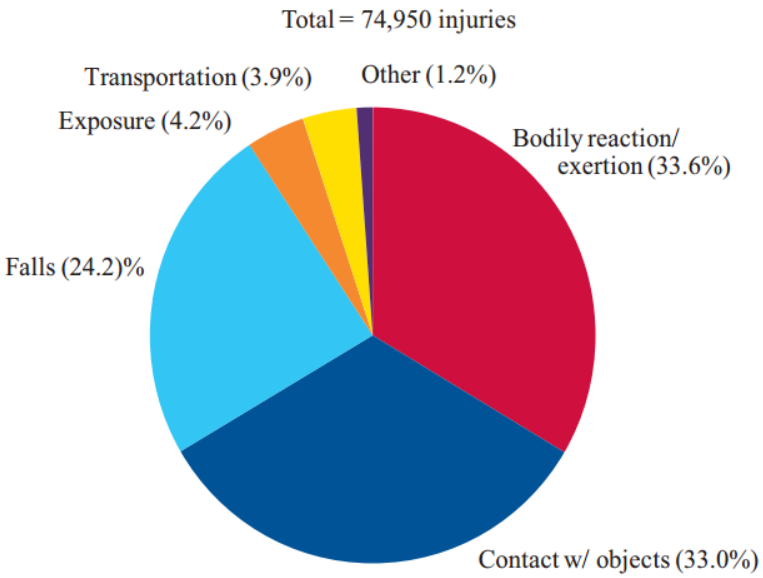

Figure 2.2 Distribution of leading causes of nonfatal injuries resulting in days away from work in construction, 2010 (CPWR 2013)

These two charts provide a robust summary of construction incident causes. The data used for these charts relates to the construction industry as a whole, and does not specifically target highway workers. The Construction Chart Book is one of the most comprehensive repositories of safety and other statistics in the construction industry.

2.3 Legal Standards and Policy Recommendations Related to Highway Workers

Federal agencies have implemented nationwide guidelines to help states improve their safety programs and protect highway workers. One of the most visible documents describing these programs is FHWA's *Work Zone Operations Best Practices Guidebook* (FHWA 2013). This report is published at the national level to assist states and provide guidance on common work zone issues. The best practices identified by this guidebook are categorized into 11 topics and 49 key-words to allow users to search the practices by a particular topic.

States have enacted their own policies and guidance for improving safety in highway work sites as well. Strategic Highway Safety Plans (SHSPs) are a requirement for state DOTs that are a part of the Highway Safety Improvement Program (HSIP). This requirement has continued under the Fixing America's Surface Transportation (FAST) Act (FHWA 2016). These programs direct the decision making of state DOTs based on the governing federal policies. Some of the state SHSPs that specifically outline priorities in work sites are summarized below.

- Illinois's SHSP describes that a particular issue in the state's work zones are incidents located on the Interstate system that involve heavy vehicles. The strategies for improving work zone safety involve three E's:

Engineering, Enforcement, and Education. The report specifically identifies that Illinois work zone speed laws are weak and do not allow for adequate enforcement (Illinois Department of Transportation 2009).

- Massachusetts's SHSP focuses on the lack of ability to specifically quantify non-fatal incidents in highway work zones. The report indicates options to improve safety that are being explored. In addition, it outlines strategies for improving work zone design and educating the public about safety in work zones (Massachusetts Department of Transportation 2013).
- Minnesota's SHSP presents detailed statistics for incidents that occurred in work zones. The data includes types of incidents and the demographics of those involved in the incidents. The report specifically recognizes that, for Minnesota, there is an over-representation of commercial vehicles involved in work zone incidents, and indicates that this is a safety focus area for the state (Minnesota Department of Transportation 2014).
- South Carolina's SHSP identifies that the state has been seeing an increase in work zone fatal and severe injury collisions. The report identifies strategies to meet an objective of preventing a continued increase in work zone related collisions like the state has seen between 2008 and 2012. Some of these strategies include improved law enforcement and first responder training relating to work zones (South Carolina Department of Transportation 2015).
- Washington's work zone safety issues are handled by the state's Work Zone Safety Task Force (WZSTF). The SHSP outlines specific strategies of the WZSTF which focus on the visibility of workers and work zones. The report also states a WZSTF priority of maintaining worker training and improving public notification of work zones (Washington State Department of Transportation 2013).

Both state and federal policies drive decision making in terms of protecting highway workers and preventing incidents. These policies vary in effectiveness based on how they are communicated and how they are implemented. In addition, the policies need to be accepted as effective for improving safety to ensure continued compliance with the policies among state DOTs.

In addition to legal policies produced by state and federal government agencies, the construction and maintenance industry also makes recommendations on programs and policies that have demonstrated the potential to improve safety. The following literature is a collection of documents describing research conducted for the construction and maintenance industry as a whole, elements of which can be directly applicable to highway work sites.

Construction and maintenance industry-wide guidelines are available that provide broad recommendations to improve safety. One example is a nationwide guideline for Australia entitled "Guide to Best Practice for Safer Construction: Principles." This text presents six principles that the authors believe are important to fostering a healthy safety culture on a worksite. These principles are the following (Fleming et al. 2007):

- Demonstrate safety leadership
- Promote design for safety
- Communicate safety information
- Manage safety risks
- Continuously improve safety performance
- Entrench safety practices

Each of these principles is similarly described and promoted in other publications on safety culture in the construction and maintenance industry as

well. While this document is not very detailed, and only provides general recommendations accompanying each of these principles, this document is good reference material to understand the different aspects of a safety program. In addition, since this document is an Australian publication, it can give safety officials in the United States a new perspective on safety programs.

As innovative safety initiatives are adopted by industry, it is important that research be produced to discuss and analyze these initiatives for the implementation of these program elements. Instituting safety programs that rely on leading indicators is becoming more accepted and more common in the construction and maintenance industry. Leading indicators represent those conditions and behaviors exhibited in a workplace that provide an indication of the level of safety performance in the workplace. In contrast, lagging indicators (e.g., injury incidence rates) provide a retrospective assessment of safety performance. Monitoring leading indicators may be new to some state agencies. When a concept is still in its infancy, it is more likely that it will be implemented incorrectly. To counter this possibility, the Construction Industry Institute published a report that outlines a nine step process for implementing active leading indicator safety ideas (CII 2012). Figure 2.3, which was provided in CII's report, explains the process in the form of a flow chart. The entire process is based on the idea of improvements and adjustments being made as necessary throughout the course of implementation.

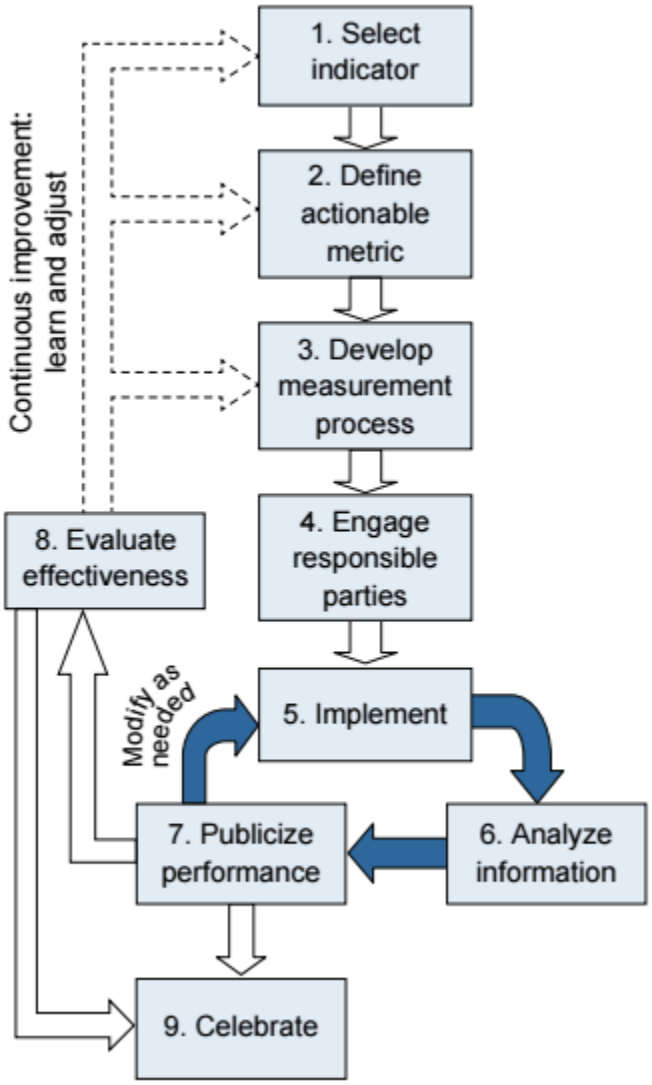

Figure 2.3 Flow chart for Implementing Active Leading Indicator Program (CII 2012)

Another initiative in the construction and maintenance industry is the "zero injury objective," whereby no incidents and therefore no recordable injuries occur on construction and maintenance sites. This objective is similar to the Toward Zero Deaths (TZD) vision that the FHWA, state DOTs, and municipalities are currently championing. This is primarily related to the elimination of transportation user fatalities, as opposed to workers exclusively,

but all are included since all loss of life is a tragedy (FHWA 2016d). According to FHWA, the TZD vision "uses a data-driven, interdisciplinary approach that FHWA has been promoting for many years. The TZD approach targets areas for improvement and employs proven countermeasures, integrating application of education, enforcement, engineering, and emergency medical and trauma services" (FHWA 2016d).

A report by Hinze and Wilson (2000) examines the progress in the construction and maintenance industry after "zero injury objective" gained traction. The authors indicated that safety programs are becoming more common and more effective. Since safety programs are becoming more common, the next logical progression is evaluating the existing programs and making improvements.

In some cases, large private construction and maintenance companies draft their own safety programs and policies that are applied on all of their projects. This requirement adds consistency to the safety regimens from project to project that is intended to improve institutional safety.

One such company, for example, is the Howard S. Wright Construction Co. (HSWCC). Their company-wide safety guide is thorough. It includes directives for administration officials as well as detailed requirements for workers in many common work scenarios like personal protective equipment, fall protection, tools, heavy machinery, and specialty machinery (HSWCC n.d.). Another company with a comprehensive safety plan is Skanska. Skanska's guidelines include policies for common scenarios like HSW, and includes provisions for subcontractors and for various emergency situations like natural disasters or terrorist activity (Skanska 2005).

Whether it is a federal, state, or company guideline or policy, it is important that these be followed by workers during the course of the work. Maintaining consistent safety programs that are easily understood by workers in highway work sites will result in safer work sites for workers and motorists.

2.4 Availability of Highway Worker Safety Data

Further understanding of the prevalence and causes of injury and fatality incidents for highway workers is possible through evaluation of data that is available to help quantify these incidents. This section of the chapter explores the different sets of publicly available data and the background research that has used or sought to improve the data sets. The data sets include those from the following entities:

- Bureau of Labor Statistics (BLS)
- Occupational Safety and Health Administration (OSHA)
- National Institute for Occupational Safety and Health (NIOSH)
- Fatality Analysis Reporting System (FARS)
- Strategic Highway Research Program (SHRP2)

This section will explore these five databases as well as other published data sources that synthesize data related to highway worker safety.

2.4.1 Injury and Fatality Databases

BLS and OSHA are both divisions of the United States Department of Labor (USDOL). BLS is responsible for collecting information on worker incidents through their Injuries, Illnesses, and Fatalities (IIF) program. This information is published on the BLS website and is searchable by industry, allowing the identification of incidents that occurred in highway work sites (BLS 2016). OSHA

also reports Investigation Summaries for fatalities and catastrophes that occur in the workplace (Note: OSHA defines a catastrophe as a work-place incident that results in the overnight hospitalization of one employee). These summaries are industry and key-word searchable in the online database (OSHA 2016). Hinze et al. (1998) highlighted the lack of specificity in root causes of construction and maintenance injuries and demonstrated that by increasing the detail of the database, the search results of relevant incidents would be more comprehensive. Since the publication of that journal article, OSHA has increased the specificity of crash causes in the database, particularly with detailed key-words. While the ability to search specifics has been improved, it is still difficult to aggregate and quantify the records in OSHA's online database.

NIOSH, a division of the Centers for Disease Control and Prevention (CDC), researches specific workplace incidents and compiles the resulting reports within its Fatality Assessment and Control Evaluation (FACE) program. The reports are very detailed and provide a description of the incident. Some of the reports are specifically related to fatality incidents in highway work sites (NIOSH 2016).

The FARS database, which is maintained by the National Highway Traffic Safety Administration (NHTSA), documents all fatal crashes on public roadways. The details of the incident that are recorded in the police report are collected and placed into the FARS database (NHTSA 2016). Over the years, the police crash reports have been consistent on how they document fatal crashes that occur in work zones. Since FARS is based on these police crash reports, the database coding has some different searchable factors over time. In 2004, a study published in the Transportation Research Record explored individual state reports and how the states quantified work zone incidents (Ullman and Scriba 2004). The study concluded that the database at the time may have been

underreporting work zone crash fatalities by as much as 10% based on the variations in forms used between states (Ullman and Scriba 2004). The FARS database does not allow the user to select "work zone" as a filter for records dated before 2009. This limitation is possibly due to the discrepancies found in the reporting of work zone incidents identified in the 2004 report (NHTSA 2016).

The Strategic Highway Research Program 2 (SHRP2), which began in 2006, is a broad program to uncover data-driven solutions to transportation challenges (NAS 2016). One element of the SHRP2 program is the Naturalistic Driving Study (NDS), which specifically focuses on improving highway safety. The project is administered by the National Academies of Sciences and the Transportation Research Board in partnership with the Virginia Tech Transportation Institute (VTTI). This research, while still being conducted, maintains an online database with some of the data collected to date, which, to different extents, can be used by researchers to better understand real-world driver behavior and analyze traffic incidents (Campbell 2012).

2.4.2 Safety Data Synthesis Publications

In addition to these national databases, there are sources that synthesize the data from these databases into various forms. This includes publications such as the Construction Chart Book and the National Safety Council's (NSC) *Injury Facts* book. These sources, described in the following

The Construction Chart Book presents data in the form of charts, figures, and graphs. While this publication presents analyses of the entire construction industry, some visuals specifically relate to highway construction and maintenance (CPWR 2013). Figure 2.4 is an example directly from The Construction Chart Book that make specific references to highway construction.

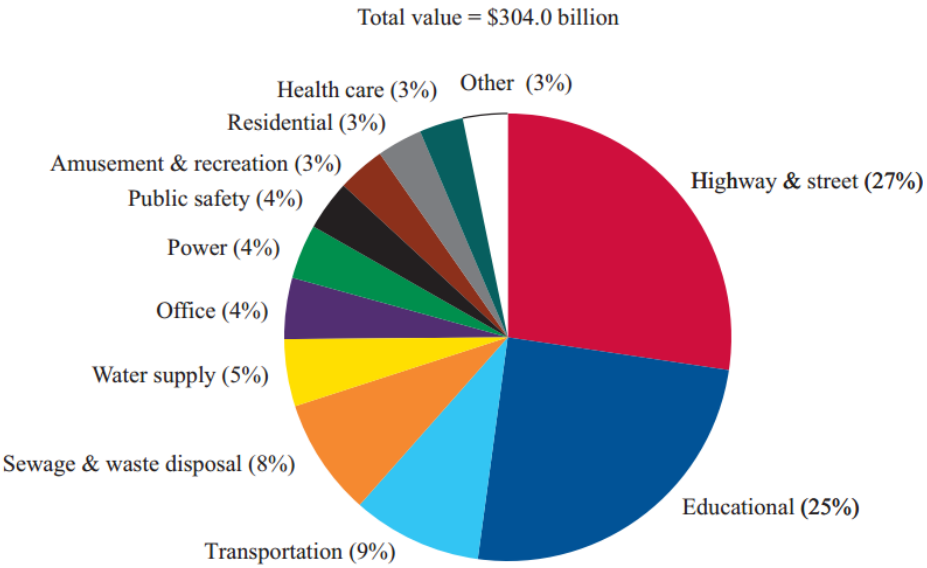

Figure 2.4 Share of dollar value of public sector construction, by type, 2010 (CPWR 2013)

Figure 2.4 is of the type of data avaliable in this reference. While the data is more useful in determining overall trends and characteristics of the construction industry, there are select tables and figures in the reference that provide insight to the nationwide highway construction and maintenance industry.

Another resource, entitled "Safety Management in the Construction Industry," (McGraw Hill Construction 2013) attempts to quantify the existance and characteristics of safety policies and programs in the construction and maintenance industry. This resource also focuses on the types of safety practices that are in use, the impact of those safety practices, influence factors, and communication and education. All of these sections provide the reader visual representations of the practices and how the practices impact (both positively and negatively) the construction and maintenance industry. The data is

particularly useful in that it shows the frequency at which construction and maintenance firms use different programs and education methods (McGraw Hill Construction 2013).

The National Safety Council (NSC) publishes an annual synthesis of injury statistics in the United States and around the world. The title of the publication is *Injury Facts*, and the content is not limited to any one industry or occupation. The statistics include a broad exploration of fatalities and injuries that occur from both unintentional and intentional (homicide/suicide) incidents in the United States and, to a lesser degree of accuracy, the world. Subsequent sections of the publication divide nationwide statistics into categories such as occupational, motor vehicle, and home and community incidents (NCS 2016). The occupational category of injury and fatality incident statistics pertains most directly to highway workers since their occupation places them at risk of injury or while on the job.

The 2016 edition of the NSC's *Injury Facts* book's section on occupational injuries and fatalities is still general in its presentation of available statistics, so it is impossible to isolate specific statistics related to highway workers. However, some of the general information can provide context in the form of potential trends in occupational incidents related to highway workers who are employed by state DOTs. Based on 2013 data, the NSC reports more than 1.1 million injuries and illnesses that resulted in time away from work that year. Of these, approximately 65,000 (6%) were state government employee. This is not limited to state DOTs, but all agencies within state government. Approximately 190,000 of the national lost time injuries and illnesses were from local government employees, the remainder being private industry employees (NSC 2016).

The NSC publication also provides some general information on the estimated economic cost of occupational incidents that occur. These costs include, in addition to worker's compensation insurance, loss of productivity and administration expenses. In 2014, the NSC estimated that the cost of each death is approximately $1 million. For every medically consulted occupational injury, the average total cost is $29,000. In addition to the monetary cost, the NSC also recorded the lost time. In 2014 in the United States, among all industries, the total time lost was 99 million days, with 65 million of those days due to work-related injuries (NSC 2016).

Other statistics, such as injury types and causes, are included in the NSC *Injury Facts* publication. However, the closest data category to isolate highway workers is the construction industry and government employees (NSC 2016). Neither of these provide enough detail to observe the unique risks and incidents associated with highway construction and maintenance workers.

2.4.3 Database Summary

In conclusion, these data sets, when used together, can help to quantify and describe current issues in highway worker safety. Understanding the functionality of each data set will allow effective research to be conducted and effective safety programs to be implemented. Highway worker safety needs to be examined at both national and state levels to understand general trends and causes of traumatic incidents. Each of these data sets has advantages and limitations. Table 2.1 is a summary of the strengths and limitations of the worker injury and fatality data sets that were examined.

Table 2.1 Strengths and weaknesses of the worker injury and fatality data sets

Data set	Strengths	Limitations
BLS	Able to separate by state; numerically based data separated by categories	Illness and Injury data not well coded to isolate for highway work sites; little known about individual incidents
OSHA	Short written description regarding each incident	Difficult to search by state
NIOSH	Very detailed reports and specific recommendations	Poor geographic diversity and few recent reports for highway work zones
FARS	Detailed, comprehensive database	Cannot isolate highway workers
SHRP2	High volume of naturalistic driving information	Not as available to non-academic researchers at state DOTs

While there are benefits to having access to various forms of the data, one of the limitations of this collection of data sources is the difficulty of combining them. The data sets are most easily analyzed independently. It is likely that individual incidents appear in more than one of the archives, but the recording methodology for each of the programs is different enough to make it challenging if not impossible to isolate a particular incident across multiple data sets. One limitation of these data sets is that they must currently be analyzed independently. The data sets present different aspects of incidents in a wide variety of formats. This diversity, while enhancing the breadth of information regarding highway worker incidents that can be accessed, limits the potential

integration of the data sets. The data analysis could be more powerful if the data sets reviewed in this section could be more easily integrated and analyzed collectively.

While state specific data is the most useful for the state DOTs, these nationwide statistics on highway worker safety can be beneficial. The statistics can be used to establish a benchmark with which states can evaluate areas of highway worker safety where the states can most improve with respect to the rest of the US.

2.5 Summary

In conclusion, this chapter has reviewed existing literature regarding current issues in highway worker safety. The collective research on the topic indicates that highway worker safety is a significant concern. Much of the literature discusses the issues related to vehicles and their effect on safety in work sites. A significant amount of research regarding the hazards of work sites from the perspective of the highway workers also exists that does not pertain to public vehicle crashes. All of this research, combined with the available data sources, provides a summary picture of current issues in highway worker safety.

The research included in this chapter has identified several elements that can be effective aspects of an agency's highway worker safety program. One of these elements is the option for the program to consider literature and data analysis practices from both the traffic engineering and construction and maintenance engineering fields. Exploring recent trends in each of these fields can lead to a more comprehensive understanding of the unique challenges in highway work sites.

Data regarding highway work sites is collected at both the Federal and state level. In order for state DOTs to be able to implement effective safety programs, it is beneficial to understand the data that is available so that it can be analyzed in some of the ways the research described in this chapter has done.

3 METHODS

3.1 Research Questions

Based on the review of the literature regarding some of the broad issues that have been previously studied in state DOT worker safety, several specific research questions were developed to guide the research methodology to most accurately review the state of practice for State DOTs documenting and promoting the safety of their employees.

The literature explored legal standards and policy recommendations related to highway worker safety that exist at both the state and federal level. While some state level safety policies are federally mandated, in many cases the specific safety foci for state DOTs are established at the discretion of the state DOTs themselves. The literature also explored the prevalence of worker injuries and fatalities in the construction industry. One aspect of reducing future highway worker incidents is the collection of accurate and timely highway worker incident data. With a wide variety of federally mandated and optional safety policies and standards, there may well be a lack of consistency regarding how state DOTs report of incident that occur in state work sites. Research Question #1 was developed as a result:

Research Question #1: *How do state DOTs respond when an incident with a highway worker occurs in a work site?*

One of the themes present in the literature review was the availability of data in different forms to determine the prevalence and causality of highway worker incidents. In addition, several databases relating to highway worker safety were explored. Generally, these databases are not well integrated with each other, but

do provide different types of data that could be useful to state DOTs in the development of highway worker safety policy and practice. The existing literature explored these topics at a national level in the public and private construction sectors. The available literature exposed a lack of understanding about these issues specifically at the state DOT level. Research Question #2 was developed as a result:

Research Question #2: *What is the current state of practice for using data to develop, implement, and evaluate state DOT worker safety programs?*

The literature review determined several sources of national data that are publically available to state DOTs, as well as internal databases that are available to the agencies. While various forms of data exist, it remains to be seen how state DOTs across the country use the data they collect to develop specific safety programs. Research Question #3 was developed to guide the exploration of the characteristics of exemplar state DOT safety programs.

Research Question #3: *Are there examples of current or recent data driven worker safety programs that have been implemented by state DOTs?*

To explore these research questions, two primary research tasks were developed. The first was a survey developed and a questionnaire sent to state DOTs safety offices to gather information about state DOT incident reporting, data collection, and data utilization. The second was semi-structured interviews of state DOT employees to create detailed case studies of specific state DOT safety programs. The next section of this chapter, "Study Approach," further explains these two research tasks.

Through these research tasks, an additional research question was developed. While it was understood prior to this study that state DOTs were varied in size and structure, the degree to which this difference manifests itself in the development of safety programs and policies at state DOTs was not recognized. The literature did not uncover any specific research regarding the institutional and structural differences at state DOTs. Therefore, the following research question was developed to explore potential impacts of the scope and structural differences of state DOTs:

Research Question #4: *How does the size and scope of a state DOT influence the agency's highway workers health and safety programs?*

These four research questions, when answered in combination, provided the opportunity to create a comprehensive review of the state of the practice within state DOTs regarding the promotion of the safety of the highway workers employed by state DOTs. The following sections describe the specific methodology used to collect both qualitative and quantitative data that could be used to help answer these specific research questions.

3.2 Study Approach

Two research tasks were used to provide answers to each of the four research questions. The first of these is a survey developed with a questionnaire to be distributed to solicit information from safety officials at each of the state DOTs. The questionnaire portion of the survey included questions regarding state DOT actions in the aftermath of a worksite, which were included to provide data and findings for Research Question #1. Other questions in the questionnaire were aimed at state DOT data collection and used to inform Research Questions #2 and #3.

To further address Research Questions #2 and #3, a second research task was implemented. The second research task involved conducting several case study investigations of safety programs being used by individual state DOTs. Each case study included semi-structured interviews with state DOT employees, several specific questionnaire items, the review of internal DOT documents, and the review of publicly available data and documents. The questionnaire explored national trends specifically related to the research questions, while the case studies provided a more detailed understanding of individual state DOT safety programs. The combination of these two research tasks provided a more robust set of results as they related to the research questions. The following subsections describe in detail the methods used to execute these two research tasks.

3.3 Survey Questionnaire

The goal of the survey was to obtain useful and detailed information about the safety programs currently in place within state DOTs across the US. A critical consideration in conducting the survey was to balance the ability to obtain the desired information while allowing the questionnaire itself to be short and simple enough to navigate and understand to achieve a high response rate from state DOT safety offices. For the data gathered from the survey questionnaire to be useful in summarizing national trends, a target response rate of 80% of the US states (40 of 50) was established.

The methodology section of this chapter outlines the process for conducting the survey and the procedure for gathering responses. The first goal was to create a logical format and progression of items within the questionnaire document that was easily comprehended by survey participants. The second was to have

effective questions that solicited the following information about state DOT safety programs and practices:

- Data sources that are available to state DOTs, how the sources are archived, and their robustness
- How data is analyzed and used by the state DOTs
- Policies and practices that have been implemented to mitigate highway worker safety risk
- Agency perspectives on safety policies and practices

Questions were organized into the following four sections to collect the desired information as described in the previous list:

- Demographics
- Incident reporting
- Data collection
- Data utilization

The focus of the questions was improved understanding of national trends related to these aspects of state DOT policies and practices. The collection of information directly from state DOT employees allowed the researcher to obtain first-hand information about safety programs from individuals who regularly work with them and are invested in their successful implementation. However, this also resulted in the possibility of data being based on estimates or personal impressions by one or more state DOT employees regarding the safety programs.

The survey questionnaire was drafted and underwent several internal revisions. The questions were then coded into Qualtrics, an online survey software, to provide an easy to navigate and common interface for respondents of the

questionnaire (Qualtrics 2002). The complete survey questionnaire that was distributed to state DOTs is included in Appendix A.

With the assistance of National Cooperative Highway Research Program (NCHRP) panel members, a link to the Qualtrics-formatted questionnaire was distributed to safety representatives in each state DOT. The questionnaire was initially distributed using an email list of the members of the North American Association of Transportation Safety and Health Officials (NAATSHO). NAATSHO is an organization whose purpose is to communicate and distribute information regarding health and safety policies between state DOTs. NAATSHO members are volunteers who are predominantly employees in the safety departments of state DOTs. For some states, the NAATSHO email list contained multiple employees in the state. For these cases, emails were sent to all of the employees in the state who were on the NAATSHO list. As a result, emails containing the link to the survey questionnaire were sent to a total of 63 NAASHTO members. In this initial distribution, two emails returned as undeliverable.

After the initial email and a reminder email from NCHRP, the total number of questionnaire responses received was between 15 and 20. The research group followed up with more reminder emails over the course of two weeks and the total survey responses increased to approximately 30. To achieve the 80% response rate target, the research team conducted follow-up phone calls and emails with the NAATSHO members to solicit more responses. In addition, the research team contacted colleagues at state DOTs that had not yet responded to find appropriate safety personnel who would be willing to take the survey questionnaire. After two weeks of these approaches, the researcher met the response target (at least 40 of the 50 states). In total, 41 states (82%) had a

representative respond to the survey questionnaire. This number of responses exceeded the initial goal of 40 states (80%) that was set at the beginning of this Thesis.

To preserve the anonymity of the respondents, the states, and the state safety programs, no state was specifically identified with a response unless permission has been granted by a representative of that state DOT. States may be identified as part of broad national regions. It is not the purpose of this chapter to identify specific state programs but instead observe general trends common to state DOTs across the nation.

To organize the data to be more useful in answering Research Question #4, the following methodology was used to explore the difference between state DOTs based on size. State DOT size is a characteristic that can meaningfully differentiate states. To preserve the anonymity of the states and still provide general trends based on the characteristic of state DOT size, a categorical scheme was established. FHWA reported 2013 state DOT disbursements (total expenditures of each state DOT in 2013) and this measure was selected as a reasonable proxy for state DOT size. The following four ranges of disbursements were defined (FHWA 2013b):

- <$1 billion in disbursements
- $1-$2 billion in disbursements
- $2-$4 billion in disbursements
- >$4 billion in disbursements

These four ranges were selected to have an approximately equal number of states per category. Several of the questionnaire responses were sorted by these categories. These are included in the tables in Appendix B. In these tables, each

code (e.g., A1, B3, C5, etc.) corresponds to a state. The "A" states are all in the <$1 billion in disbursement and they are randomly sorted within the "A" category. This method was used for the other categories as well. These categories allow trends between state size to be highlighted without compromising the anonymity of the questionnaire respondents. Some of the qualitative responses in Appendix B were edited to preserve state anonymity.

3.4 Case Studies

After the survey responses were collected, the responses were combed for evidence of noteworthy safety program elements. The goal for determining these noteworthy elements was to follow-up with the state DOTs about these programs and develop case studies that explored, in detail, the aspects of each of the safety programs. This exploration focused on the existing use of data in state DOT safety programs.

To obtain the detailed information required to compose the case studies, it was first necessary to identify which states to contact for follow-up interviews. Several factors guided the selection process for potential interviewees. The final question of the survey questionnaire sent to the state DOT safety representatives gave the respondent the option to include their name and contact information if they were interested in participating in a follow-up interview to discuss further their safety program. Twenty-three of the respondents indicated their willingness to participate in the follow-up interview. The research team then analyzed these 23 responses for mention of specific safety programs that may be unique or interesting to highlight in case study format. Of these 23 responses, nine contained information about safety programs that the researcher found to be worth exploring further.

While the population of interest for follow-up interviews was limited to states who participated in the questionnaire and were willing to provide contact information for a follow-up interview, highlight case studies were identified from state DOTs in different regions of the United States to provide a distributed geographic representation. A total of nine states were contacted to participate in a follow-up interview. Phone interviews were successfully coordinated with seven of these state DOTs, listed here in alphabetical order:

- California
- Maine
- North Dakota
- Oregon
- South Carolina
- Virginia
- Washington

These states represent various regions in the United States, including the northeast, west, southeast, and the plains. The included state DOTs exhibit diverse characteristics. The populations range from more populous states like California and Virginia to some of the smaller population states like Maine and North Dakota. Table 3.1 lists the seven states, their estimated 2015 population, and their population rank among the 50 states.

Table 3.1 State population and rank for interviewed state DOTs (U.S. Census Bureau 2015)

State	Population (2015 est.)	Population Rank (2015 est.)
California	39,144,818	1
Maine	1,329,328	42
North Dakota	756,927	47
Oregon	4,028,977	27
South Carolina	4,896,146	23
Virginia	8,382,993	12
Washington	7,170,351	13

Once candidate states were identified, interview protocol was drafted with primary and probing questions based on the case study objectives as defined by the Thesis scope. The interview questions aimed to gather supplemental information to the survey questionnaire responses, and focused on the use and collection of data in the process of implementing and maintaining the specific safety program elements identified. The questions also sought to ascertain details on the agency's perspectives and evaluations of the program or initiative. The full interview protocol is included in Appendix C. After this document was completed, the interviews were conducted on the phone and audio recorded with the interviewee's permission. Each interview, which lasted between 15 to 35 minutes, allowed the state safety officer to explain the safety program element in their own words, with only guiding questions from the researcher. After the interviews were completed, the audio files were transcribed to text to allow the case studies to be more easily drafted.

In addition to containing the information gathered from the interview and survey process, each of the documented case studies includes basic information about the state DOT that implemented the safety program element. To gather this additional information, the researcher reviewed online information about the state DOT that is publicly available on the state DOT's website and information in any documents provided by the interviewee that describe the state DOT's safety program elements. This was done to establish an appropriate context for each state DOT, since they vary in terms of size and the elements of the transportation network that they construct and maintain. In each case study, only a portion of the overall state safety program was highlighted. This was done to provide sufficient detail about the program element discussed, and allowed for the exploration of a variety of programs across the United States.

4 SURVEY RESULTS

4.1 Introduction

This chapter provides the results from the questionnaire that were collected from the state DOT safety officials. The survey was developed and a questionnaire was distributed to the state DOT safety officials to provide the most accurate understanding of nationwide trends in safety programs among the state DOTs. The results presented in this chapter are the responses from the 41 state DOTs that had a representative respond to the survey.

The four sections of this chapter correspond to the four sections of the survey questionnaire. These sections were meant to provide the respondents with consistent questions that could be used to inform the research questions for this Thesis. The four sections are as follows:

- Demographics
- Incident Reporting
- Data Collection
- Data Utilization

Each of these sections provides the results from the individual questions in each of these sections. In most cases, the data is summarized or provided in a graphic format instead of as raw data to facilitate understanding of the general trends conveyed by the data.

Some of the results presented in the following sections are based on the matrix of responses to select questions that were classified by state DOT size. These matrix

tables, which are referenced throughout this chapter, are located in Appendix B. These tables contain predominantly raw results data from select survey questions. The findings from the matrix data are presented to provide additional value to the general trends identified through the questionnaire responses.

4.2 Demographics

The first section within the questionnaire asked the respondents basic demographic questions regarding their role in worker safety and general information about their agency. This information is important in order to understand the background, experience, and job roles of the individuals completing the survey questionnaire. In addition, since all state DOTs are structured and function differently, it was necessary to try to quantify the diversity among the states. The data collected in this section, along with publically available metrics to describe the DOTs, were used to develop a more accurate and complete understanding of state DOT diversity.

The questions relating to the state DOT representative responding to the survey questionnaire included requesting their job title and the number of years that they have worked with their current agency. Figure 4.1 shows a distribution of the number of years of experience of the respondents. In total, the 41 respondents had a combined 625 years of experience at their current agency, with an average of 15.2 years per respondent and a median of 15 years. The minimum was one year and the maximum was 30 years.

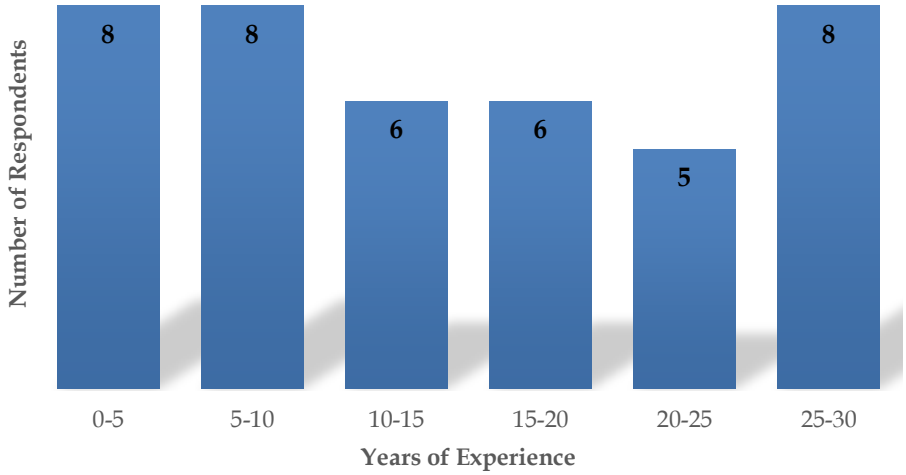

Figure 4.1 Frequency of responses by respondent's years of experience (n = 41)

The job titles of the respondents varied widely and included such diverse titles as "Safety and Risk Manager," "Statewide Safety Security and Emergency Coordinator," and "Highway Safety Inspector." Table 4.1 provides a summary of how frequently various safety and managerial related words appeared in the respondent's job titles. There will be greater confidence in the results if the survey respondents have roles within the state DOT that provide accurate knowledge and perspectives of the state DOT safety programs and give them access to information about safety programs and incident reporting practices. The high frequency of the words in Table 4.1 serves as partial justification for the validity of the results of the survey.

Table 4.1 Job titles of respondents that contain key words (n = 41)

Key Word	Number of Titles	Percentage of Titles
Safety	36	88%
Risk	5	12%
Health	7	17%
Manager/Coordinator	17	41%
Director/Administrator	9	22%

Many of the job titles included multiple key words listed in Table 4.1. For example, the job titles "Risk Management Safety Officer" and "Occupational Safety and Health Training Manager" contain three of the words in Table 4.1. It is not surprising that the word "safety" was well represented in the job titles. In fact, of the 41 state representatives who responded, only five had titles that did not include the word "safety." Of these five, some contain the word "risk" or are generic "Program Director" or "Program Administrator" titles.

To demonstrate further that the respondents to the survey questionnaire were knowledgeable about their state safety programs, the questionnaire asked the respondents how often they "work with worker injury claims and prevention programs." Figure 4.2 is a histogram distribution showing the frequency that the respondents work with injury claims and prevention programs.

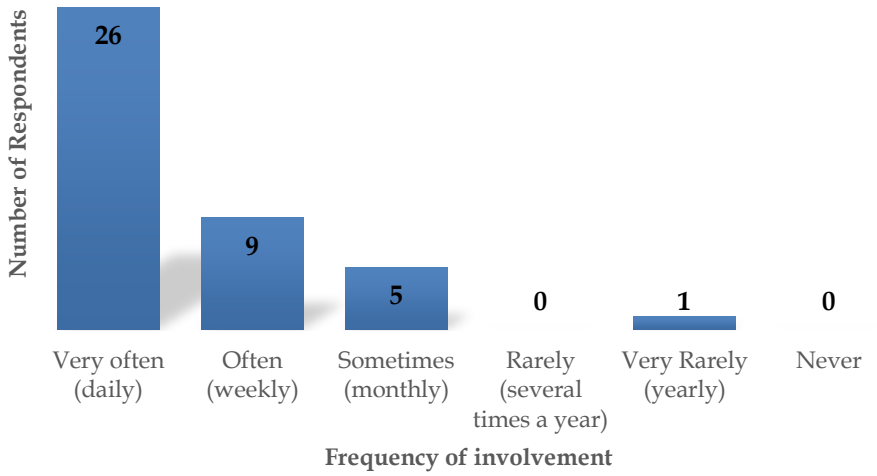

Figure 4.2 Frequency that respondents work with injury claims and prevention programs (n = 41)

The most striking aspect of Figure 4.2 is that a majority of the respondents (63%) work with injury claims and prevention programs on a daily basis. As a follow-up question to the frequency that they work with these programs, the respondents were asked to describe their specific role with these programs. The respondent who selected "Vary Rarely (yearly)" for the frequency question (see Figure 4.2) followed up that his/her particular, "office oversees the Departments [sic] Safety program, but has no role in processing or overseeing claims." So even respondents who may not work with claims and prevention programs as frequently were still invested in some aspect of the safety program in their agency.

In response to the question asking the respondents to describe their role with worker injury claims and prevention programs, two general trends were present across the descriptions. The first is that the respondents are managers of these claims and programs. Their roles were to collect the information and then

manage the claims and programs based on the data collected. The second trend is that many of the respondents are also involved specifically in the implementation of safety programs, particularly the training aspects of the programs.

The other questions in this section of the questionnaire referred to the characteristics of the state DOT that the respondent was representing in the survey response. The questionnaire asked the following two questions regarding the characteristics of the agency:

- What is the approximate size of your agency in total number of employees?
- What is the approximate percentage of your agency's employees who are regularly on construction and/or maintenance sites?

Figure 4.3 and Figure 4.4 are histogram distributions presenting the frequency of each response.

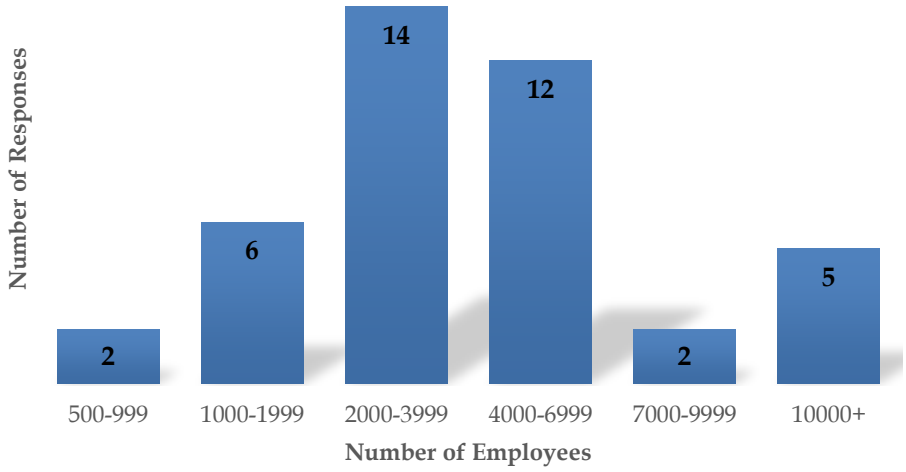

Figure 4.3 Distribution of the state DOTs by number of employees (n = 41)

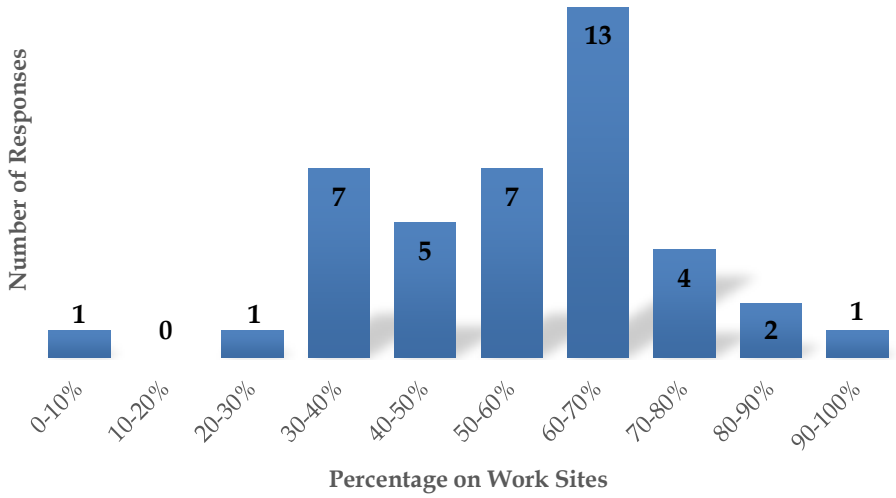

Figure 4.4 Distribution of the state DOTs by percentage of employees who are regularly on work sites (n = 41)

These questions aimed to demonstrate not only the diversity of the state DOTs, but also the number of workers who are experiencing higher safety risk by spending time in highway work sites as a part of their job. Based on these two questions, a rough estimate of at least 75,600 state employees nationwide are regularly on construction or maintenance sites. This underscores the volume of human life that is at risk of injury in work sites and further justifies the importance of this Thesis.

4.3 Incident Reporting

The second section in the questionnaire related to how the agency responds when injury incidents occur with their employees. The focus of these questions is to get a sense of the national practice among state DOTs for the process that is followed when an injury incident occurs on a job site. The questions specifically

relate to the process for reporting and archiving incidents that occur with state highway employees in highway work sites.

4.3.1 Post-Incident Steps

The first question in this section provided the respondent with a list of potential steps that could be taken by the state DOT after an incident has occurred in a highway work site. The research team separated these work site incidents into three different types:

- Public Automobile – incidents involving vehicles owned by the public that enter highway work sites
- On-site Vehicle/Equipment – incidents involving vehicles and equipment that are allowed in the highway work site and are typically used to conduct the work
- On-site Hazard – incidents in the highway work site that do not involve a vehicle or equipment

Figure 4.5 shows a summary of the frequency of each post-incident step for each of the three types of work site incidents as defined by this Thesis.

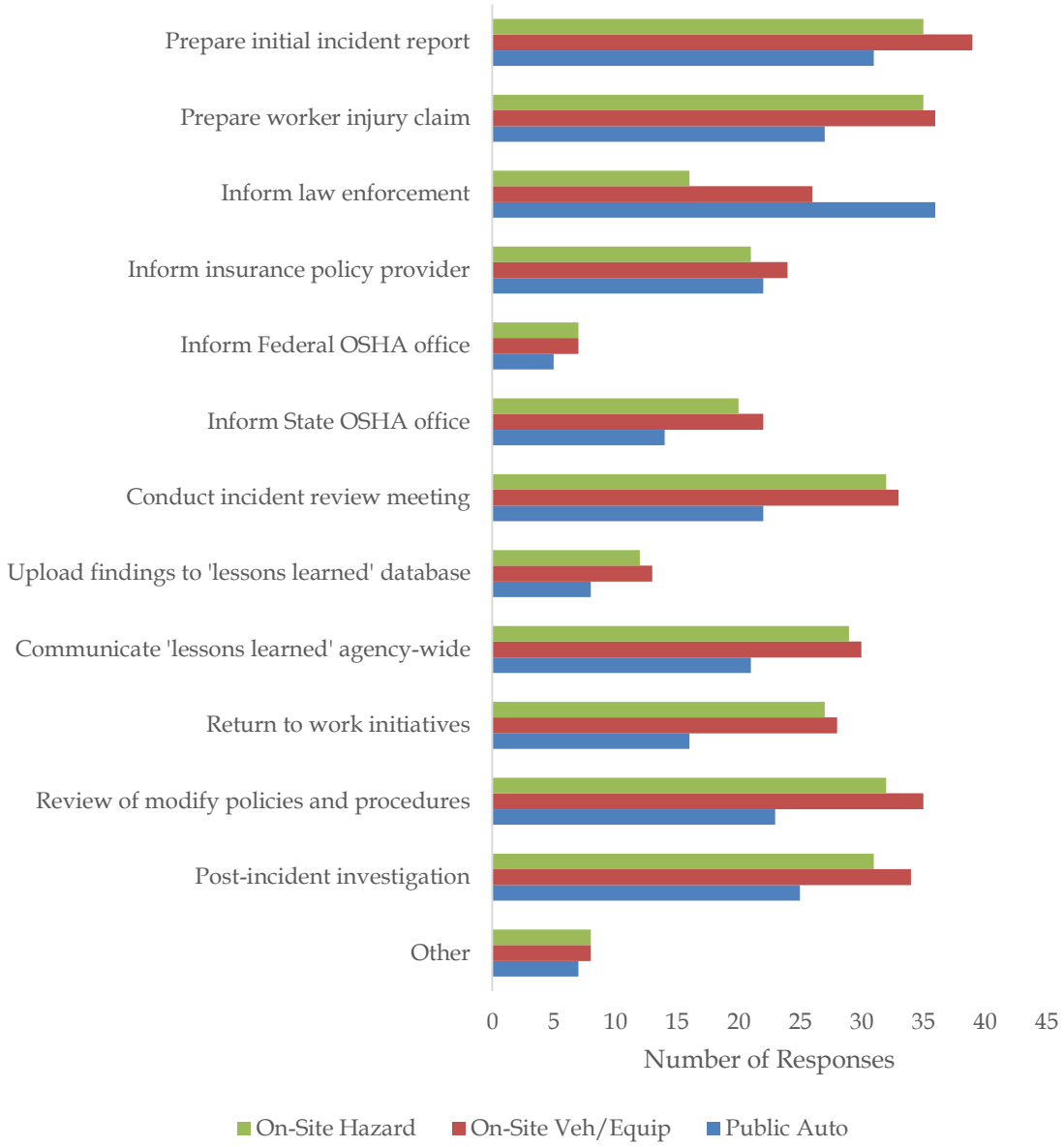

Figure 4.5 Frequency of post-incident steps by type of incident (n = 41)

As seen in Figure 4.5, many of the steps listed in the questionnaire are taken by the state DOTs following a work site incident. The figure reveals that the steps have similar clusters around the three types of incidents. Generally, each of the steps received a similar number of responses across the three incident types. This

result indicates that the reporting procedures for the state DOTs are similar regardless of the type of incident. The notable exception is the "inform law enforcement" step, which is more frequently taken in public automobile incidents. This step appears far less common following the two other types of incidents. For all the incident types, "Upload findings to 'lessons learned' database" and "Inform Federal OSHA" are the least employed of those steps listed.

To gauge the effectiveness of the steps that state DOTs identified, respondents were asked to rate the effectiveness of each step that their agency took after an incident occurs in a work site on a roadway. This effectiveness is judged according to how well the step contributes to the success of the agency's safety program. The respondents were asked to rate the effectiveness of each step using a scale of 1 to 5 (1 = not effective, 5 = very effective). The overall average effectiveness rating for the public automobile incident steps and on-site hazard steps was 3.7, and 3.8 for the on-site vehicle/equipment incident steps. Communicating 'lessons learned' agency-wide was indicated by the respondents as a very effective step across all three of the incident types (average rating = 4.0). The highest average effectiveness rating (4.3) was associated with informing Federal OSHA for on-site vehicle/equipment incidents, and the lowest average (2.9) was related to informing law enforcement about incidents resulting from on-site hazards. Tables B1a-B1d in Appendix B present a summary of the average effectiveness of four selected post-incident steps according to the self-reported respondent perspectives. These steps include communicating 'lessons learned' agency-wide, return to work initiatives, reviewing or modifying policies and procedures, and post incident investigations. Tables B1a-B1d divide responses

based on the four disbursement categories and report the average effectiveness based on those categories for the three types of incidents.

4.3.2 Archiving Process

Three questions in this section of the questionnaire related to the state DOT's incident report archiving process. The first of these questions asked which departments at the agency are responsible for compiling and archiving incident reports. Figure 4.6 shows the frequency of departments that respondents identified as having a role in compiling and archiving incident reports. Respondents could select all departments that applied.

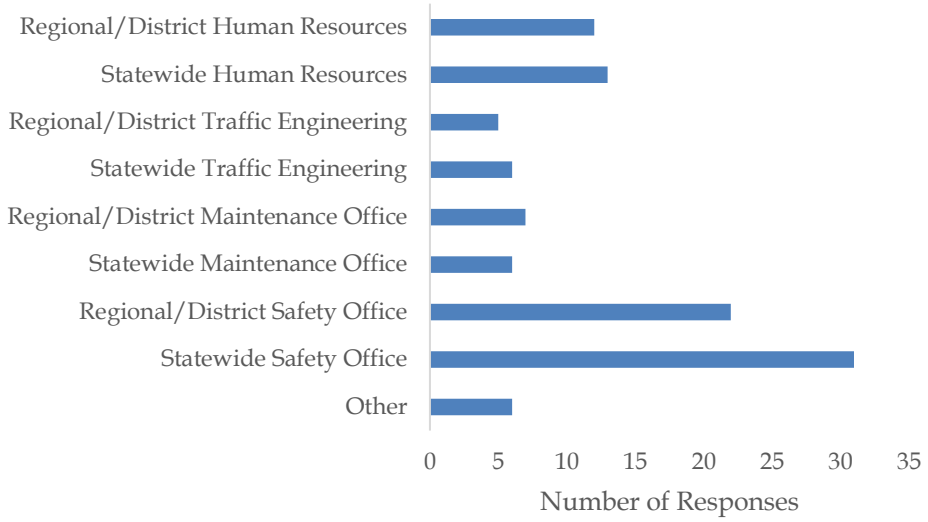

Figure 4.6 Frequency of agency departments that have archive responsibilities

As is shown in Figure 4.6, the safety offices (regional or statewide) are the most predominant location for compiling and archiving incident reports. Many state DOTs have multiple departments across disciplines contributing to and maintaining the archive of incident reports. Some of the "Other" responses for this question included Emergency Operations and the Claims office.

The second question asked what format is used to archive incident reports at state DOTs. Figure 4.7 shows the frequency that each format is used to maintain the archive of incident reports. Respondents could choose more than one format if their incident reports are archived in multiple ways.

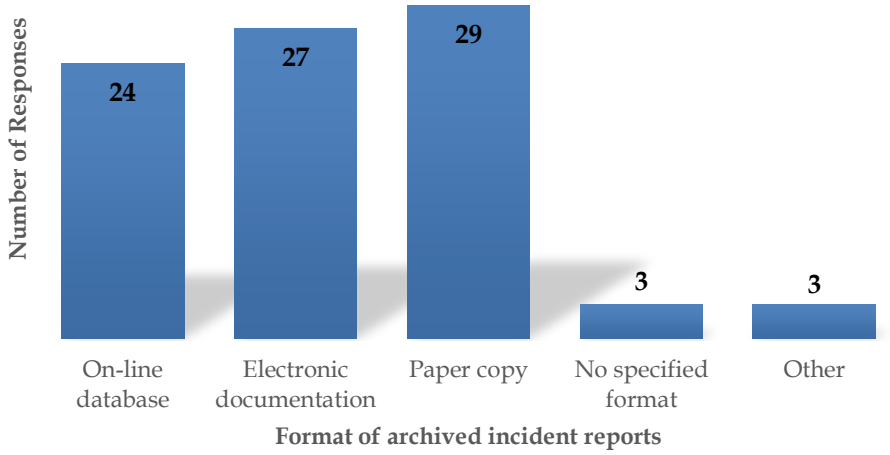

Figure 4.7 Frequency of format of archived incident reports

The third question related to archival processes of incident reports asked respondents to identify how incident reports are categorized. Figure 4.8 presents a summary of the frequency of the categorization type for incident reports that state DOTs compile and archive.

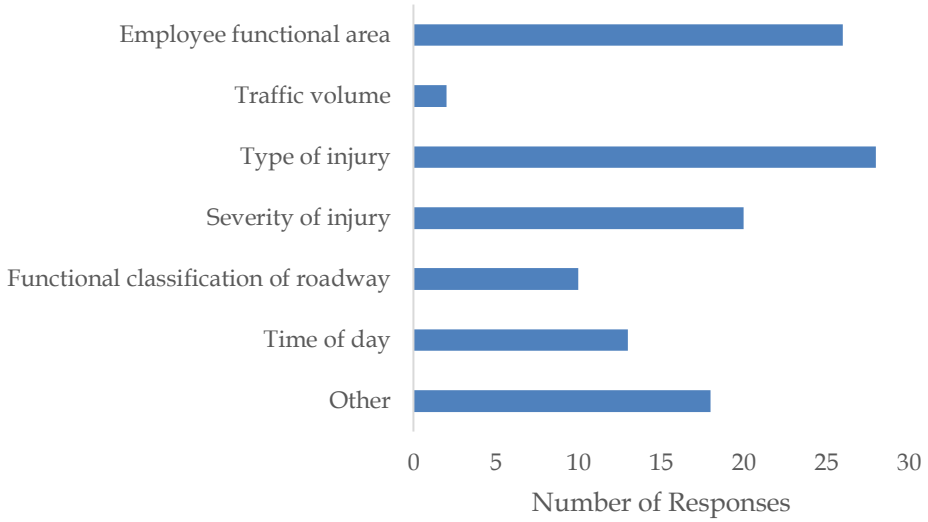

Figure 4.8 Frequency of categorization type for archived incident reports

It is encouraging that many state DOTs use multiple means of categorization to archive their incident reports. For the eighteen (18) respondents who selected "Other", many indicated that their data sources are also categorized by the date on which the incident occurred. Table B1d in Appendix B indicates that the largest states (disbursement >$4 billion) are more likely to have an "Other" type of categorization. In fact, 78% of these states used an "Other" type of categorization, while between 30% and 38% of the states with $4 billion or less in disbursements used an "Other" type of categorization for incident reports. Maintaining several methods of categorization can allow the reports to be easily queried when needing to find a specific incident or using data to implement and evaluate safety initiatives.

4.3.3 "Near Miss" Reporting

Several of the questions in this section of the questionnaire referred to "near miss" incidents that occur on work sites. Only 44% (18 of 41) of the respondents

to the survey questionnaire indicated that their agency has a system currently in place to report a near miss incident.

For the states that do have a near miss reporting system (18 states), nine use the same reporting process for a near miss as they do for other incident types. Among the nine states that have a different reporting process for a near miss, some of the differences included the following:

- Similar forms to actual incidents, but less detailed information for near misses
- Near miss incident reporting is optional
- Different administrative communication track for near miss incidents

Descriptions of the near miss reporting processes for states that have them is included in Tables B2a-B2d in Appendix B. One state DOT provided a particularly detailed account of their near miss reporting process. When a near miss incident occurs, the foreman reports the incident to the county manager. This manager then, in turn, reports the event to the state DOT's district safety coordinator who completes a special notification form and submits it to an employee safety group. This group distributes details of the incident to the executive staff at the agency. This entire process only takes a few hours.

For those states that do not have a reporting system for near misses, the questionnaire prompted the respondents to select from a list of choices the reason that the agency does not have a near miss reporting system. Figure 4.9 shows a distribution of the reasons why agencies do not have this system in place.

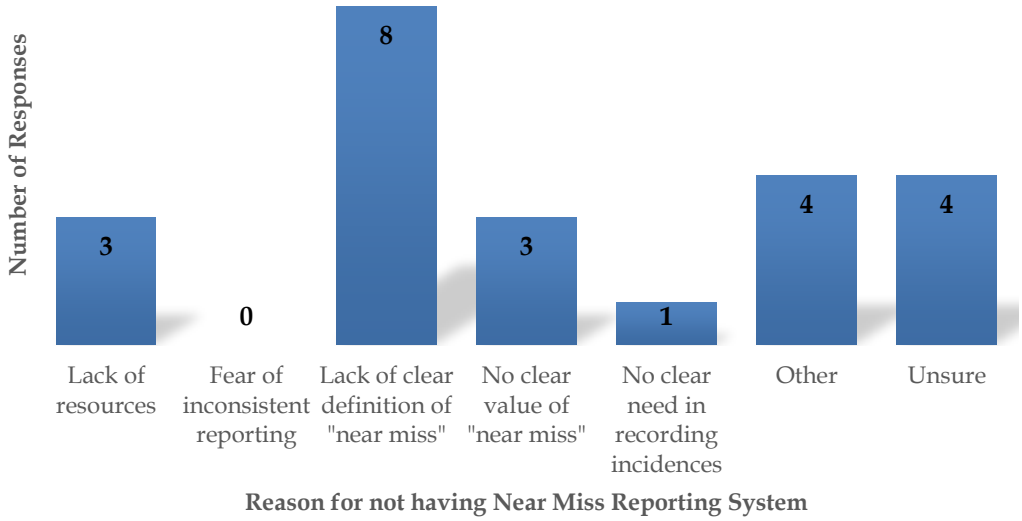

Figure 4.9 Distribution of reasons why agencies do not have a near miss reporting system

The primary reason for not having a near miss reporting system was the lack of a clear definition of a near miss. Further research and education efforts within state DOTs and the construction and maintenance industry more broadly could standardize the definition of a near miss so that the reporting of these incidents can become more common and standardized among state DOTs. A consistent definition of near miss across state agencies could help identify national trends regarding near miss incidents. Additionally, educating state DOTs about the value in tracking near misses to overall safety performance, and the connection of near misses to injury incidents would help promote the implementation of near miss reporting systems. It is important to note that decreasing near misses is not the final solution for improved safety, as they are less likely to decrease fatalities since they primarily target reducing less severe incidents.

4.4 Data Collection

The third section of the questionnaire sought to determine the sources of data that are available and used by the state DOTs regarding highway worker safety. The first question in this section asked respondents to indicate if a particular data set is available to their agency. In addition, respondents were asked whether the available data sets are actually used by their agency. Figure 4.10 shows, for each of the data sets, how many state DOTs have the data available, and how many actually use that data set.

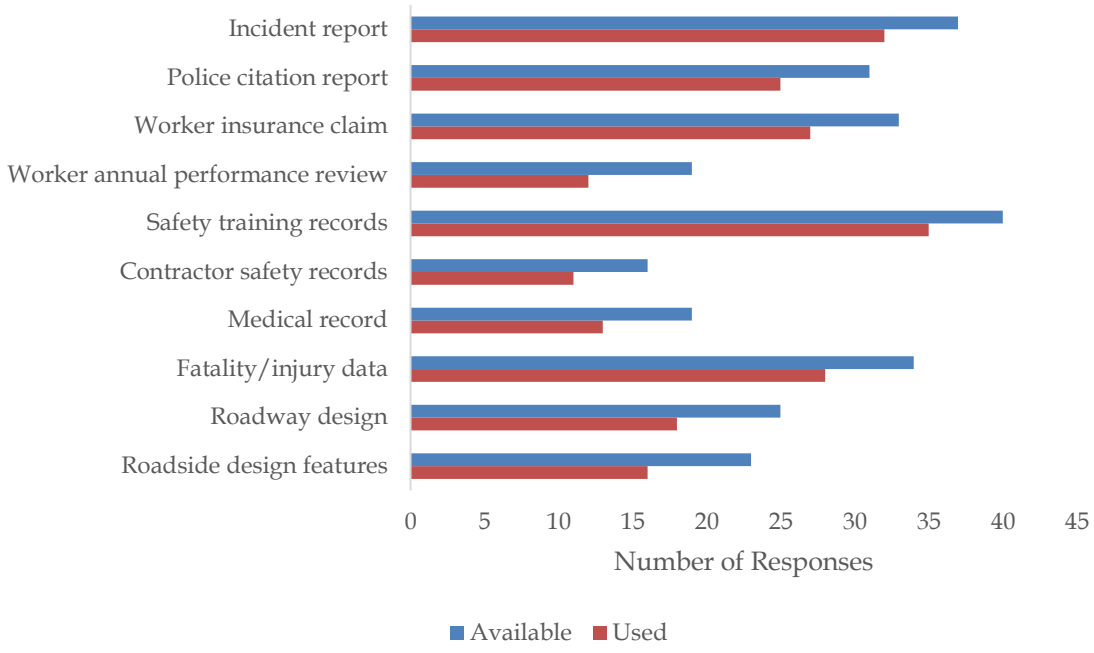

Figure 4.10 Frequency of availability and usage of data sets (n = 41)

The results shown in Figure 4.10 are indicative of how state policies and/or practices might restrict information from safety personnel due to confidentiality concerns. For example, the three data sets with the least availability to the state DOTs are "worker annual performance review," "medical records," and

"contractor safety records." In some cases, it is possible that individual employee records (performance or medical) may be protected by state policy and cannot be used in the development of safety programs.

Additionally, for each data set, some state DOTs have access to the data set but the agencies do not currently make use of that particularly data set. According to the survey questionnaire responses, there were approximately six states with access to any one particular data set, but were not using it currently. Leveraging all pertinent and readily available data is one approach to improve data driven safety programs. If pertinent data are already being collected and archived, the costs associated with integration into a safety program would be measurably reduced.

Respondents were then asked, for data that was either available or used by their agency, how complete the data is based on a scale of 1 to 5 (1 = very incomplete, 5 = very complete). For further detail on the results of this question, and to see the data categorized by state DOT size, refer to Tables B3a-B3d in Appendix B. Table 4.2 shows the average completeness rating each data set received.

Table 4.2 Average completeness rating for each data set (1 = very incomplete, 5 = very complete)

Data set	Average Completeness Rating
Incident report	4.0
Police citation report	3.9
Worker insurance claim	4.2
Worker annual performance review	3.7
Safety training records	3.6
Contractor safety records	2.9
Medical record	3.3
Fatality/injury data	4.1
Roadway design	3.9
Roadside design features	3.9

Three of the data sets received an average rating of 4.0 or better in terms of their completeness: "Incident Report," "Worker insurance claim," and "Fatality/injury data." These data sets contain some of the core safety documents used for developing safety initiatives, and the documents are likely required by law in their state. Therefore, it is not surprising that these data sets received the highest completeness ratings.

The overall average completeness rating for all of the data sets is 3.7. This result is encouraging and indicates that, when the state DOTs have access to a particular data set, the data is reasonably complete and therefore would be beneficial in agency decision making regarding safety programs for workers in work sites.

In addition to completeness, another important characteristic of the data sets is the length of time after an incident that the data is available for use by the state DOT. The results showed that internal state DOT structure and processing have the greatest impact on the time after an incident that the data becomes available for use. No one data set generally takes more or less time than the others. For example, of the 41 responses, 21 state DOTs have access to all of their available data sets within three months. In contrast, ten state DOTs must wait more than a year to have access to all of their available data sets. This disparity indicates that no single data set takes a certain amount of time to become available. Table B4c in Appendix B provides a summary of the time required for data to be available to state DOTs. This table indicates that the smallest states (<$1 billion in disbursements) may have access to data the fastest. Eighty-four percent of the data that is available to the smallest states is available within one month. No other size group has that level of data availability within that period. Further analyzing the processes of state DOTs that have quick turnarounds with their data sets would be beneficial for states that experience longer latencies between the occurrence of an incident and the availability of datasets.

Having data available to state safety personnel quickly after an incident allows the statewide safety strategies to be updated and adjusted based on current trends. These adjustments ensure that safety strategies are based on current trends and are thereby most effective at protecting state workers in highway work sites.

The ways in which state DOTs analyze available data to promote highway worker safety is also of interest. As such, respondents were asked if their agency has conducted "any research or data analysis regarding highway worker safety in work sites on roadways and workers' compensation related to injuries." Only

39% (16 of 41) of respondents stated that their agency conducts this type of research. For agencies that conduct this analysis, the primary method involves examining past incident statistics and other internal reviews of historic data. Some agencies collaborate with outside organizations like FHWA or an in-state university to perform safety data analysis and research.

Thirteen of the respondents identified data sources that are not currently available to their agency but which they believe would be beneficial. Some of these desired data sources included data from other state DOTs and from other government agencies (Federal, municipal, etc.). Other agencies wanted more integration of their current databases to more effectively categorize and understand incidents. Tables B5a and B5b in Appendix B list the descriptions of data sources that respondents felt would be beneficial for their state. The following three responses exemplify types of desired data:

- An accident database with information about the types of vehicle crashes with state DOT equipment
- Information from private road management companies working for the state and from local municipalities
- More detailed worker compensation data including lost and restricted time

Despite the presence of state DOT research and analysis regarding highway worker safety, there is a need to make further strides toward equipping state DOTs with the data that can be the most benefit to state DOT safety programs. In addition, it is vital that state DOTs be able to conduct internal research and collaborate with research institutions to extract the most value out of collected data.

4.5 Data Utilization

Similar to the third section of the questionnaire, the fourth section continued to query respondents about data sources that are available to state DOTs. However, the questions in this section focused on how state DOTs implement data that is available to them as part of safety policies and practices.

To help determine the frequency that data is used, one question in the survey provided a list of policies and practices that could be developed from the data (either internal or external data) and asked the respondents to indicate whether data was used in the development of the policy/practice. Table 4.3 is a summary of the list of policies and practices presented in the question and the number of respondents who indicated that their state DOT had used data to develop the listed policy or practice. Respondents were able to select all policies/practices that applied.

Table 4.3 List of policies/practices presented in question and the number of agencies that indicated they used data to develop the policy/practice (n = 41)

Policy/Practice	Number of Responses	Percentage of Responses
Additional training for workers	37	90%
Additional Training for Supervisors	34	83%
New standards for work site traffic control plans	28	68%
Driver awareness programs	27	66%
Worker behavior assessment programs	13	32%
Safety incentive programs	10	24%
Drug/alcohol abuse programs	18	44%
Other	4	10%
None	0	0%

Additional training options were the most prevalent forms of data driven implemented practices. For the four respondents who selected "Other," two of the agency respondents cited programs relating to personal protective equipment (PPE). In addition, two respondents indicated that data has made their agency consider a safety incentive program, and one respondent used data to revise existing policies and procedures.

Table B6a in Appendix B separates the responses to this question regarding the use of data to develop programs or policies at state DOTs. For the "Driver Awareness Programs" and "Drug/Alcohol Abuse Programs," the smallest states (<$1 billion in disbursements), more than any of the other three size groups, used data to implement these programs. The percentage of implementation was more than 20% higher than the implementation percentages for those two programs from state DOTs with disbursements of $1 billion or more.

Another question asked to what extent the state DOT shares the information it has collected with other organizations. The collection of data can be time consuming and expensive, so the more that existing information is shared, the more efficient and effective other organizations can be in terms of their safety programs. Table 4.4 presents a summary of the list of organizations presented in the question and the number of respondents who indicated that their state DOT shares data with that organization. The list of organizations was designed to include various levels of government agencies as well as non-governmental entities. Respondents were able to select all agencies/organizations that applied.

Table 4.4 Organizations with which the state DOT Shares Data (n = 41)

Organization	Number of Responses	Percentage of Responses
Federal agencies	19	46%
Other State DOTs	23	56%
County/Municipal governments	7	17%
Private Organizations	6	15%
Other	10	24%
None	9	22%

Sharing data with other state DOTs was the most common response. This response is encouraging since state DOTs have similar roles and needs for similar forms of information. For the respondents who selected "Other," there was an assortment of types of organizations that the respondents described. Some agencies share data with professional organizations such as the American Traffic Safety Services Association (ATSSA). Other state DOTs share information with other state agencies or in-state research universities. Unfortunately, a large percentage (22%) of the respondents (9 of 41) indicated their state DOT does not share information with any other organization. All of these groups can benefit from sharing data with each other to make highway work sites safer.

The final question of the survey solicited ideas from the respondents regarding recommendations for other state DOTs to implement successful safety programs. The following are paraphrased examples of these recommendations:

- Encourage involvement in safety programs from all levels of the agency to ensure that management supports safety programs demonstrated to be effective for employees.
- Use the latest technology and keep the programs updated. Take advantage online training.
- Share safety policies and practices with other states so that the successful programs can be shared between the state DOTs.

4.6 Summary

The approach of gathering information regarding state worker safety policies and practices through a survey captures some understanding of current state DOT safety programs. In addition, the survey allows for capturing present circumstances and challenges experienced by state DOTs with respect to their safety programs. As is described in the previous sections of this Thesis, state DOTs are very diverse. Each state DOT experiences its own set of issues, but remains committed to improving the safety of its employees in highway work sites. With this diversity comes opportunity.

By obtaining responses from 41 state DOTs, the results capture much of this national diversity. The respondents represent states from all regions in the United States. Where some state DOTs have invested time and money into a new safety program, others have invested into other programs and ideas. From a nationwide highway worker safety perspective, sharing the research and program methods is an economically efficient means to potentially improve worker safety nationwide. While institutional limitations might prevent some state DOTs from following the model of other state DOTs that have a successful

safety program element, understanding fellow state DOT safety programs can still be useful in adapting broad safety ideas to a new organizational context.

There are distinct limitations of the survey approach to gathering this information and making generalized conclusions with confidence. To make the questionnaire as user-friendly as possible, the questions were predominantly limited to numerical and multiple-choice responses. This format may have limited the depth of some responses and directed the respondents' thinking in a way that would not have been the case in open response questions. However, it was necessary to make the questionnaire simple and quick to complete to achieve the required response rate. A minimal number (ten) of open response questions was included in the survey. Also, reporting results from these types of questions and maintaining the anonymity of the states means these qualitative results can only be reported in broad terms.

Improvements in data sharing and data availability will be helpful in allowing states to make data-driven decisions for their safety programs. It is the hope that this chapter has provided a better understanding of national trends relating to state DOT data gathering and utilization practices for highway worker safety. This chapter has highlighted general opportunities for improvement that can be implemented at the state DOT level. The implementation of some of these opportunities can lead to more consistent nationwide safety practices and raise awareness of safety issues experienced by state employees working in highway work sites.

5 STATE DOT CASE STUDIES

5.1 Introduction

The purpose of this chapter is to further investigate and highlight specific examples of state DOT safety program elements that have been developed and found to be effective. The nature of the survey was to describe national trends and practices. While this is critical to an overall understanding of highway worker safety practice among the state DOTs, it is also important to document and share specific and interesting efforts by state DOTs that could benefit all agencies. These case studies are informative examples of various elements within state programs. These case studies describe the current state of data-driven health and safety policies and practices in state DOTs.

Both Research Question #2 and Research Question #3 guided the methodology of the research to conduct and report these case studies for specific state safety programs. Not only do these case studies continue to expand on the broader understanding of the current state of practice for state DOTs using data to develop and use worker safety programs, but they also represent specific data-driven examples of worker safety programs that have been implemented by state DOTs.

As stated in Chapter 3 – Methods, the following sections will contain the results from the case study investigations for seven state DOTs. These states, listed in alphabetical order, are as follows:

- California
- Maine
- North Dakota

- Oregon
- South Carolina
- Virginia
- Washington

Each of the following sections is the write-up for the case study of an element of a safety program from the DOT in each of these states. Each of the case studies includes general information about the DOT collected from online resources about its size and scope. In addition, there is a general description of the particular safety program that is being reviewed. The rest of the subsections for each case study describe at the data sources, monitoring and evaluation, effectiveness, and summary recommendations for each of the safety programs at each of the state DOTs.

5.2 State: California

5.2.1 DOT Size and Description

The California Department of Transportation (Caltrans) is one of the largest state DOTs. The agency has approximately 20,000 employees who work together to effectively implement a $12 billion budget with the common goal of fulfilling Caltrans' mission to, "provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability" (Caltrans 2016). Physically, this goal involves the management of 15,000 center line miles (51,900 lane miles) of highways that are located on 230,000 acres of right-of-way in the state of California (Caltrans 2014). The Caltrans' survey response, included in Chapter 3, estimates that between 30% and 40% of the agency's employees are regularly on construction or maintenance sites throughout the state. Many of

these workers are maintenance workers who have higher risk to high-speed traffic exposure due to their required work tasks.

5.2.2 Design for Safety Initiative

Highway worker safety is an important focus for any state DOT. In recent years, Caltrans has dedicated additional time and resources to ensuring that workers committed to constructing and maintaining the California highway system are as safe as possible. As one element of this overall goal, Caltrans has implemented a Design for Safety initiative. This is a program element of the State Highway Operation Protection Program (SHOPP) that addresses highway worker safety at Caltrans through funding of capital improvement projects. The Design for Safety initiative focuses on using data to identify particular areas where improvement is needed to reduce worker exposure and communicate these issues with the landscape architects and engineers so that they can produce designs that minimize or eliminate the potential risks placed on workers in the field. Subsequent sections of this case study will describe the specific data that is used, how it is analyzed, and how that analysis influences design practice.

In 2012, a Deputy Directive, which is the second highest level of directive at the agency, focused on worker safety for the State Highway System was distributed agency-wide. This directive outlined the responsibilities for all Caltrans employees on their role to help protect worker safety and minimize potential risk. The Deputy Directive's involvement of all employees helped to motivate and integrate design landscape architects and engineers in the effort to improve work site safety. It also supported Maintenance involvement in design decisions to reduce worker exposure.

To comply with the Deputy Directive and ensure that the available funding was appropriately used, officials at Caltrans looked to other state DOTs to see what guidance was available for effective worker safety programs. Little guidance regarding roadside worker safety specifically, and especially guidance in designing for safety was found. Most of the available literature provided guidance solely for roadway traveler safety. Therefore, the implementation of a more robust worker safety initiative in California needed to be more experimental and serve as an example of a construction and maintenance worker focused safety initiative at a state DOT. The Design for Safety initiative is an integral part of the current worker safety programs at Caltrans.

Design for Safety suggests that all elements of the Department can play a role in ensuring and maintaining worker safety. In particular, this initiative focuses on the impact that the designers can have on the safety of workers who construct and maintain their designs. During the implementation process, analysis of worker injury and fatality records was conducted to establish the areas of highest risk for workers. Further explanation of the data sets used and the subsequent analysis of the data is included in the "Data Sources, Archiving, and Analysis" subsection of this case study. Additionally, statewide workshops conducted in each of Caltrans 12 districts with maintenance staff to solicit ideas from the people who regularly perform job tasks in the field to determine what actions would create a safer environment for them. This series of workshops, held between 2013 and 2014, identified over 750 unique ideas. These ideas and the results from the data analysis were used to create tools and training programs for the designers to use in practice. The Department granted district level authority for the implementation of changes that can improve worker safety. This increases

the efficiency with which design exceptions can be made and allows safety efforts to be implemented more quickly.

The Landscape Architecture Program in the Division of Design manages the SHOPP Roadside Safety Improvements Program. A handout intended for Caltrans employees outlines the goals and objectives of the Roadside Safety Improvements Program. The document describes, for many types of design decisions, the design options that are potentially eligible for funding through the program. The handout also describes types of work and decisions that do not qualify for SHOPP Roadside Safety Improvement Program funding. Although the handout contains the full list of approved and not approved design solutions for program funding, the program is based upon soliciting new design ideas that may improve highway worker safety. The Design for Safety initiative is one of the mechanisms in place at Caltrans to achieve the goals and objectives for the Roadside Safety Improvements Program.

There are additional guidance tools for the Design for Safety initiative. These practical measures better equip designers to incorporate safety into designs. One of these, the Roadside Management Toolbox (Caltrans 2014), is a web-based platform that provides options to designers for different circumstances. It describes the potential risks to highway workers for different design elements so that designers can make informed and intelligent choices. In addition, there are design guidance documents specific to different groups (e.g., Landscape Architecture) that provide recommendations specific to the work product of those functional groups.

The Caltrans Highway Design Manual (HDM) requires the Safety Review Committees in each District approve all designs. These committees are an

independent group operating in each of the districts that ensures the proposed construction and maintenance plans consider the implications to highway worker safety. These reviews ensure consistency across each district for promoting risk reducing design decisions.

The Design for Safety initiative continues to be improved. SAFER is an acronym developed by the Landscape Architecture Program, to highlight the different ways design decisions can improve worker safety in a way that is easy to remember. The acronym is short for:

- Site – site facilities in protected locations.
- Accessible – provide safe access for highway workers to work locations.
- Facilitate – facilitate the use of mechanical maintenance means.
- Eliminate – eliminate the need for recurring maintenance tasks
- Relocate – relocate facilities to protected locations.

One of the current goals is to get the SAFER Design philosophy integrated in the HDM. For example, when deciding where to place a utility cabinet on a project site, a designer can consider if the box can be located in such a way that it is accessible to the workers while maximizing the distance to the travel way, thereby reducing the risk of exposure to adjacent traffic. As the Design for Safety initiative continues to develop and become a more integral part of Caltrans' overall safety program, incorporating elements like the SAFER philosophy will continue to reduce worker risk.

5.2.3 Data Sources, Archiving, and Analysis

The primary source of data that guided the development and implementation of the Design for Safety initiative was an existing database that contained fatality

incident information between 1924 and 2007, as well as injury incident information between 1990 and 2006. Officials at Caltrans organized and analyzed the entirety of these data sets to determine trends and establish focus areas where interventions could contribute to the greatest reduction of risk. The analysis included evaluating each of the incidents for specific characteristics. These characteristics included the location of the worker at the time of the incident, the task the worker was conducting at the time of the incident, and the type of injury sustained by the worker. From the analysis of the data, the following five common factors were identified as areas where workers are operating at the highest level of risk:

- Urban locations
- High Average Daily Traffic (ADT)
- Vehicle parked on the shoulder
- Roadside work near the shoulder
- Employee on foot

While these five situations can occur independently on a worksite, the risk to workers increases when multiple situations appear in a single worksite. For example, an employee performing maintenance work on foot near the shoulder of a road in an urban area with a high ADT presents one of the highest risk situations to workers.

In the Design for Safety initiative, these five factors are the primary targets for available design solutions. Solutions to these worst-case situations were created to mitigate the safety risks for workers. These design solutions can be categorized by the components of the SAFER acronym, and highlight specific strategies that can be implemented in a variety of situations. The injury and

fatality database used by Caltrans made the identification of these issues possible and gave the engineers the opportunity to develop effective solutions to mitigate risks to workers in the field.

5.2.4 Monitoring and Evaluation

The primary method for monitoring and evaluating the Design for Safety initiative is an internal review. By continuing to implement additional training and maintaining employee participation in the program, the Design for Safety initiative can evolve naturally to accommodate the changing needs of the maintenance workers and the transportation network. To date approximately 200 Caltrans employees, including Landscape Architects, Planners, Engineers, and Maintenance employees, have participated in the Landscape Architecture Academy training, which focuses on work site safety. Additionally, the Maintenance Leadership Academy has trained hundreds of maintenance staff in Design for Safety concepts. Continued annual funding of the SHOPP Roadside Safety Improvement Program is also a way to monitor the health of the initiative from the perspective of agency leadership.

Caltrans has implemented an effort to document the specific changes that have been made in designs because of the Design for Safety initiative. In some cases, such as projects that re-locate signal or utility control cabinets, these changes can be recognized and documented. However, this documentation is far from complete since the goal of the initiative is to make thinking about safety in design something that is a standard part of the design process. These little changes occur in the day-to-day revisions of the designs to improve worker safety, but are almost impossible to document as a part of a monitoring program for the initiative. In addition, while injury and fatality data is still collected by Caltrans,

this data is not actively used in the evaluation of the Design for Safety initiative. According to the Caltrans safety team, it is difficult to prove the direct correlation between a physical change and a reduction in the number or severity of incidents, so using incident data as a metric is currently not a practical method to manage roadside safety improvement investments.

5.2.5 Effectiveness of Safety Programs, Policies, and Practices

The Design for Safety initiative has been an element of a significant restructuring of Caltrans that has been in place for several years. There are still elements, such as the SAFER acronym, that are in the early implementation phase, but the bulk of the initiative structure has been established. Therefore, several metrics exist that demonstrate the effectiveness of the Design for Safety initiative at Caltrans.

One of the indicators for the success of the initiative has been the agency leadership's support. The SHOPP program, of which the Design for Safety initiative is an element, has enjoyed leadership approval and seen significant increases in funding as a result. In 2010, the SHOPP program had an annual budget of approximately $1.9 million. Through effective advocacy by program management to agency leadership, safety officials at Caltrans were able to demonstrate the specific needs for the safety program, and were provided additional funding to meet identified statewide needs. Over the course of several iterations, the annual budget for the SHOPP Roadside Safety Improvements program has increased to approximately $90 million today. This 47.4 fold increase in funding demonstrates the confidence of the leadership in the benefits of this initiative for the safety of highway workers.

The Design for Safety initiative has catalyzed tangible safety improvements at Caltrans. Beyond the designers making conscious choices daily to consider the

safety implications for the construction and maintenance workers in their design products, other, longer term, adjustments have been made as well. Chief among these was the modification of the standard construction plans that Caltrans uses for many of its projects. These standard plans save designers and the agency time and money, so it is advantageous to use them as often as possible. Caltrans was successful at changing the standard guardrail plans to include paving underneath the guardrail. This design prevents vegetation from growing and the need to be trimmed by maintenance workers at the edge of the travel way. The adoption of this standard plan has reduced the number of hours that maintenance workers have to be on foot at the edge of the roadway, where guardrail is present. There have been additional changes to design standards that also require vegetation control at structure approaches and other fixed objects.

5.2.6 Recommendations for Safety Programs, Policies, and Practices

The Design for Safety initiative requires inter-departmental cooperation at various levels of the organization to ensure that the initiative maximized highway worker safety while maintaining its return on investment as an aspect of the overall Caltrans safety program. For Caltrans, the following recommended practices increase the possibility of having a continuing successful safety program:

- Recognize that all Caltrans Divisions and Programs can impact worker safety, and it is important to engage every group and use them to contribute toward reducing worker risk

- Use existing data sources to highlight and understand contemporary safety concerns so that department resources can be properly allocated to maximize the return on investment

- Maintain a robust training program to educate the necessary participants and stakeholders about the impact they can have on worker safety
- Allow district autonomy to implement safety improvements to ensure that risks can be reduced as early as possible in the lifecycle of the roadway and project

5.3 State: Maine

5.3.1 DOT Size and Description

The Maine Department of Transportation (MaineDOT) was officially organized in its present form in 1972. This re-organization placed ferries, seaports, transit services, airports, and some railroads under the jurisdiction of the agency. Today, the MaineDOT is responsible for the maintenance and operation of the following transportation infrastructure elements (MaineDOT 2016):

- Nearly 18,000 miles of highway, including 2,919 bridges
- Seven ferry boats and terminals
- Three seaports
- Twenty-two transit operations with more than 420 transit vehicles
- Almost 500 miles of state-owned railroad

MaineDOT is one of the smaller state DOTs in the nation with approximately 1,900 employees. However, 60-70% of the employees are regularly on construction or maintenance sites throughout the state.

According to a report published by MaineDOT in 2010 entitled "Connecting Maine," the mission of MaineDOT is to provide "a safe, efficient and reliable transportation system that supports economic opportunity and quality of life"

(MaineDOT 2010). The report further elaborates on this mission by describing the vision of the agency as a desire to "maintain village and urban centers, connect communities and transportation modes, improve our existing transportation system performance for passengers and freight, provide a safe transportation network, and support Maine's economic vitality through connectivity to internal and external economic markets" (MaineDOT 2010). Part of reaching the goals of these statements is ensuring the safety of state employees. The following sections provide a brief overview of the general characteristics of MaineDOT's employee safety efforts, as well as a more detailed description of a safety incentive program implemented for the state employees.

5.3.2 Safety Idea Incentive Program

MaineDOT recognizes the importance of maintaining a safety program that continually adapts to changing attitudes and needs of the agency. It also recognized that establishing safety programs from the bottom-up could be beneficial in encouraging employee participation in a program. Through discussions with the work crews, the safety team at MaineDOT developed and implemented a safety idea incentive program in 2012.

The premise of the program was to collect safety ideas from the work crews around the state. These ideas were intended to be actionable items that, if implemented, would reduce the risk to the employees. The ideas included activities such as using automatic flaggers for work sites and painting lines on the sidewalks to indicate drop sites for snow and ice.

Every month, safety ideas are collected from work crews and then evaluated at the regional level. The regional safety committees then select one winner from that region. The winner is selected by the committee based on the idea it deemed

to be most actionable and valuable to reducing the risk of the employees. The winning crew then receives 50 points per person in the committee. The winning ideas from each region are then sent to the state safety office, where a statewide winner is selected. The same process that selects the regional winner is used to select the statewide winner. The crew that submitted the statewide winning idea then receives an additional 50 points per person. If any of the winning ideas are implemented statewide, the crew that submitted that idea receives additional points.

The points are the incentive aspect of the program. Each 50 points equates to about $25. The points can be used to purchase safety related items from a provided catalog. This custom catalog created by MaineDOT includes items from various vendors. The catalog contains options for safety gear such as high reflectivity shirts and jackets, winter gear such as hats and coats, and personal gear such as flashlights and tape measures. These items all contain the phrase "Safety Wins" on them to indicate that they were acquired through the safety incentive program.

In addition to the crews receiving the incentives from submitting winning ideas to the program, the monthly regional and statewide winning ideas are published on posters that are distributed to the regional offices around the state.

Ultimately, the program was active for three years (2012-2014). Toward the end of the program, many of the safety ideas that were being submitted were repeats of previous ideas, and MaineDOT management was less involved with the process as many of the best ideas had already been implemented. Many of the safety improvements made during the program are still in place statewide today, including the poisonous plant pocket guide, the inclusion of tick removal kits in

First Aid kits, painting boxes on sidewalks to mark snow and ice drop zones, and others. The safety officials at MaineDOT are shifting the resources from this program to other programs that will continue to effectively engage state employees and reduce the risk to the state DOT workforce.

5.3.3 Data Sources, Archiving, and Analysis

The primary data source accessed for the safety idea incentive program was MaineDOT workers who participated in the program and submitted the safety ideas. As the ideas were submitted on a monthly basis, the ideas were collected at the regional level and analyzed by a safety committee. This analysis yielded a regional winner, and the ideas were sent to the statewide safety office. At the state level, the safety ideas were then analyzed again and a statewide winner was selected. Throughout this process, the ideas were all collected and maintained in a database. This archival process also kept track of the number of ideas that had been accepted for statewide implementation, as well as notes associated with some ideas that included barriers to implementation.

To complement the archival of the safety ideas, MaineDOT also collects statewide data on ten different performance measures such as incident rates and severity rates. These statistics serve as a more quantitative metric for analyzing safety in the state. It is the combination of these data sources, that both identify and address perceived risks and also document the actual incidents that occur, that allows the state to effectively manage the risk experienced by the agency's employees.

5.3.4 Monitoring and Evaluation

It was important for MaineDOT to consistently monitor and evaluate the safety incentive program to ensure that the funding for the program was being used as effectively as possible. By having a short turnaround time (one month) for each of the safety idea competitions, the feedback on the program and the data collected were updated frequently.

The program was evaluated by the number of safety ideas that were received from the work crews each month. Some of the work crews were more involved with the program than others. By having multiple ideas per region, the friendly competitive spirit among the work crews was higher, and the awareness of the program was also higher. Therefore, number of ideas and the quality of ideas were monitored by the officials administering the program.

In addition, the number of safety ideas that were implemented regionally or statewide was an indicator for the health of the program. Many of the regional ideas were implemented, particularly in the region where the safety idea originated. Statewide implementation was the most important metric of the effectiveness of the ideas, since it indicated that the statewide administration personnel were invested in the valuable safety suggestions that were being proposed by the work crews.

Ultimately, it was effective monitoring of the program that led to it being cancelled in 2014. By recognizing that the safety ideas that were being submitted were starting to become repetitive, the officials in charge of the program realized that it might be valuable to turn the monetary resources to another safety program. As the ideas became more repetitive, and the more pressing safety issues had been addressed, the regional managers were not as involved and

fewer ideas were being implemented statewide. Therefore, the time and energy expended for the program became too great for the safety benefits, and the attention of the safety officials at MaineDOT was turned to other programs.

5.3.5 Effectiveness of Safety Programs, Policies, and Practices

While the program was implemented, there were several indicators that the safety idea incentive program was an example of an effective safety policy by MaineDOT. The most obvious was the practical implementation of the safety ideas that were being proposed by the various work crews, especially at the statewide level. In addition, quarterly reports of safety statistics were distributed to the work crews to maintain awareness of the safety incentive program and also, on a broader scale, remind the crews of the inherent risks associated with their jobs.

Even after the program was cancelled by MaineDOT, elements of the success of the program continued to be evident. Primarily, during the duration of the program, many safety improvements were made statewide. These improvements continued to be implemented in the aftermath of the program. Therefore, even though the program no longer exists in practice, the risk that the employees are exposed to on the job site is less as a result of the time this program was active. Also, the gear that was available to the employees as the incentives for the program is still used by some of the crews that submitted the winning safety ideas.

A safety representative of MaineDOT stated that it was "a cool program, but you know, everything wears out after a while." This self-aware statement is a sign of a healthy safety program. By recognizing that the program had run its course, the safety team at MaineDOT began to focus its resources on a similar, but

different safety program. This new program, which is in the implementation phase, is establishing team awards for good safety records like no lost time, etc. A program keeps the same spirit of the safety incentive program alive while approaching it from a different perspective to achieve continued involvement in the MaineDOT safety initiatives.

5.3.6 Recommendations for Safety Programs, Policies, and Practices

An effective safety program needs to be diverse and be broad to account for the greatest variety of high-risk scenarios that employees of state DOTs encounter on a regular basis. MaineDOT's safety program recognizes the importance of this idea, and has therefore developed a safety program responsive to employee needs. The MaineDOT safety program, and particularly the safety incentive program, highlight the following recommendations:

- Monitor the safety program throughout its duration to assess the continued success of the effort
- Understand that these safety programs may not be permanent, and know when it is time to shift focus to other strategies
- Maintaining the agency management's participation in the program is vital to its continued success
- Look for safety initiative ideas from the work crews themselves, as the individuals who assume the most risk are also likely to contribute valuable insight on the best ways to mitigate that risk

- Integrating work crew members into the safety management process helps to gain interest and buy-in from the workers regarding safety and improves the safety climate within the organization

5.4 State: North Dakota

5.4.1 DOT Size and Description

The North Dakota Department of Transportation (NDDOT) is one of the smaller state DOTs in the United States and only has between 1,000 and 2,000 employees. The responsibilities of the agency are broad, and primarily include maintaining over 8,500 miles of roadways and over 4,800 bridges throughout the state as well as managing vehicle registrations and licensing. In addition, NDDOT has a role in the capital planning of highway, rail, transit, bicycle and pedestrian facilities in North Dakota (NDDOT 2016). Despite a large section of the department being involved with the vehicle registration and licensing branch of the agency, it is estimated that between 60% and 70% of NDDOT employees are regularly on construction or maintenance sites, thereby being exposed to the higher safety risks associated with work tasks in these areas.

5.4.2 Leading Indicator Initiative

This case study will highlight two parts of NDDOT's general safety program. The first of these is an agency-wide push to transition to focusing more on being proactive in employee safety and not only being reactive to incidents after they occur. The transition to proactive safety initiatives has led the NDDOT to establish leading indicators to be monitored and evaluated, along with the traditional lagging indicators. The motivation for this change stemmed from similar initiatives being used in the plains region of the United States among

private construction and maintenance firms. The following three points are the primary lagging indicators that NDDOT analyzes to evaluate and inform its safety program (*Courtesy:* NDDOT):

- Incident rates
- Experience modification rates associated with workers' compensation insurance premiums
- Motor vehicle accident rates

The first step in the transition to relying more heavily on leading indicators was to identify which leading indicators would be recorded and analyzed as part of the safety program. Several of the leading indicators include recording employee participation in various programs like self-inspections, first aid/CPR training, the near miss program, and employee suggestion programs. Other leading indicators reflect the activities of employees with respect to safety such as employees performing safety audits and leading Pre-task Plan meetings. Still others include attendance at Safety Committee meetings and daily/weekly safety meetings. The combination of these many factors comprises the bulk of the leading indicators being monitored by NDDOT.

One particular aim of this initiative is to shift the safety culture away from finding fault in incidents. By focusing on the prevention measures for future incidents, the understanding of safety becomes a more future oriented, proactive task rather than a reactive one. This effort is being motivated in part by needing employees to buy into the leading indicator idea.

One of the visible manifestations of this agency trend toward leading indicators is the implementation of NDDOT's Job Hazard Analysis worksheet. This worksheet, referred to as Job Hazard Analysis internally at NDDOT, is consistent

with the industry standard JSA analysis. The purpose of this worksheet is to document the various tasks that are accomplished by field personnel and identify the potential hazards associated with the task, which include issues related to the work location, the environmental hazards, and particularly risky characteristics of the task. One section provides a risk rating table, so that the activity can be rated in relation to other risky tasks that could be undertaken, and further warn the employee of the risks associated with the task. This risk rating table is shown in Figure 5.1.

RISK RATING TABLE

This table is used to calculate whether the hazard you have identified is **Extreme: 9-10** **High: 7-8,** **Medium: 5-6** **or** **Low: 3-4**

The objective of rating the risk is to lower the risk by initiating risk control measures. The score is noted in the JSA risk score column on the next page – both before & after risk control measures have been nominated.

Likelihood: How likely is it to be that bad?	**Consequences:** how severe an injury?			
	Death	Serious Injuries	Medical Treatment Req'd	1st Aid req'd
Almost Certain - Expected to Occur	10	9	8	7
Likely – could happen sometime	9	8	7	6
Moderate – could happen but not likely	8	7	6	5
Unlikely – *could* happen but very rare	7	6	5	4
Rare - *could* happen but probably never will	6	5	4	3

Figure 5.1 NDDOT JSA Risk Rating Table (*Courtesy:* NDDOT)

The worksheet also includes a list of applicable precautions that should be taken by the NDDOT employee for the task and the equipment that is recommended to complete the task safely. The final portion of the JSA is a description of the process that should be undertaken by the NDDOT employee to complete the task as safely as possible.

5.4.3 Return to Work Initiative

The second part of the safety program that will be highlighted is NDDOTs return to work initiative. This initiative is being implemented concurrently with the

leading indicator initiative and both have overlapping goals. The primary leading indicator aspect of the return to work initiative is implementing an ergonomic assessment for all new hires in the state DOT.

The goal of this initiative is to be proactive in determining potential issues that could arise with a particular person in a particular position. At this point, this initiative has only been implemented in the vehicle registration and licensing area of the state DOT. An ergonomic assessment is conducted for any new employees who will be working in the vehicle registration and licensing area of the state DOT. The ergonomic assessment is an unusual aspect of a return to work initiative since, in general, no incident has yet occurred. However, the justification is that if the ergonomic assessment allows the agency to be proactive in limiting preventable incidents, then the need to return to work will not be necessary. In addition, even if an incident does occur, the ergonomic assessment can be used to tailor a return to work plan for that particular employee based on their individual needs.

NDDOT has one insurance program that is required to cover all state employees. This requirement results in a close relationship between the insurance company and NDDOT. The safety program takes advantage of this relationship to help implement programs like the ergonomic assessment as part of a return to work initiative. The safety personnel can work in conjunction with the insurance company to promote and implement this plan, further increasing agency-wide awareness of the initiative. The return to work initiative is still in its early stages, but the program will hopefully become more accepted and be implemented statewide for a range of employees and tasks.

5.4.4 Data Sources, Archiving, and Analysis

One of the primary data sources that is available for the leading indicator initiative is the state JSA form. This form is a valuable data repository for various tasks that are performed by NDDOT workers and contains detailed information about hazards and risks associated with a particular activity. However, the collection of the forms themselves serves as another data source. The more forms that are completed and archived, the more that leading indicators are recognized by the state employees and accepted as a part of the agency's safety culture. This results in a higher likelihood of safer outcomes and improvements in lagging indicators.

In addition to the collection of these worksheets that highlight the potential risk of various tasks, NDDOT has access to several data sources available regarding highway worker safety and incidents, and uses all of the available sources in its safety program implementation. These sources include incident reports, worker insurance claims, safety training records, medical records, and fatality/injury data. NDDOT integrates these sources to facilitate programmatic decision making to plan ahead and mitigate risk and loss. The safety team is fortunate that for the data sources that are used, the data is available quickly after an incident. For most of the data sources, the information is available within one month of the incident. Only the safety training records, which can take more than a year to become available, are not available for quick analysis.

5.4.5 Monitoring and Evaluation

One of the challenges associated with focusing a safety program around leading indicators is that the indicators are more challenging to quantify and evaluate for their effectiveness. Therefore, the agency will continue to monitor the same

lagging indicators they evaluated previously. This effort particularly involves the understanding of incident rates and general trends associated with those rates. In addition, the monetary indicator for the insurance premiums is of particular concern to the agency officials who want to ensure that North Dakota's tax dollars are well spent.

Another step taken by the agency is to determine the employee perspectives on the safety initiatives. To do so, NDDOT distributes an agency-wide employee satisfaction survey. The results of this survey indicate that the safety programming elements of the agency have the highest satisfaction among the state DOT employees. In particular, employees are very supportive of the trend of removing fault finding in the aftermath of incidents.

As the programs continue to be implemented and adjusted statewide, the monitoring and evaluation process will be further developed. Ultimately, lagging indicators, such as injury and fatality rates, will be used as a check on the impact of the full safety program that NDDOT has implemented to protect its workers.

5.4.6 Effectiveness of Safety Programs, Policies, and Practices

Since the safety programs described above are still in the development phase, it is too early to ascertain the long-term effectiveness of the implementation of these initiatives. The implementation of the leading indicator initiative is only 60-70% complete, so the full results are unknown. While leading indicators are more challenging to assess, the continued use of lagging indicators can partially demonstrate any effects the use of leading indicators among employee safety efforts may be having.

The first of these lagging indicators is the agency insurance premiums. This is a very visible indicator and represents a significant budget item for the agency. As the focus at the agency has shifted to leading indicators, the insurance premiums have decreased, suggesting a perceived reduction in risk (and potentially a reduction in incidents) from the perspective of the insurance provider. Over the last six years, the agency has seen a decrease of 50% in their insurance premium. This change is a significant difference, bringing further attention to the efforts of the safety officers at NDDOT.

The safety team at NDDOT also has determined that agency administration support is necessary for effective implementation. Initially, they received some skepticism for their program ideas. However, the team found that they received increased support from the administration as a result of positive outcomes of programs (from both the perspective of a more respected safety culture and the direct monetary savings from insurance). This recognition has resulted in the safety team being granted more autonomy to implement other "out of the box" initiatives aimed at improving safety within the agency.

Of the standard post-incident steps that NDDOT takes after an incident, a few of them are particularly valuable to the effectiveness of the state's safety program for its workers. For all of the types of work site incidents (public automobile, on-site vehicle/equipment, and on-site hazard), NDDOT finds that the preparation of initial incident reports, preparation of worker injury claims, and return to work initiatives are very effective and valuable to the overall safety program at the agency. For those incidents that involve on-site construction and maintenance vehicles and equipment and those that involve on-site hazards, the steps of informing the insurance provider, communicating "lessons learned" statewide, and updating the JSA are very effective.

5.4.7 Recommendations for Safety Programs, Policies, and Practices

The management of a successful safety program results from a variety of factors. These factors are necessary in both the implementation stage of an initiative as well as the continued maintenance of a program. For NDDOT, the following recommended practices increase the possibility of having a successful safety program:

- Demonstrating to agency administration the benefits of safety initiatives to improve inter-agency relations and establish trust for the implementation of future programs
- Transition data analysis from lagging to leading indicators through efforts such as a JSA for various work tasks
- Shift agency culture from finding fault in incidents to finding solutions to prevent similar incidents
- Collaborate safety initiatives across departments to take advantage of various pockets of expertise and success
- Take advantage of opportunities to promote safety programs throughout the agency to educate employees about the benefits

5.5 State: Oregon

5.5.1 DOT Size and Description

The Oregon Department of Transportation (ODOT) is an intermediate sized DOT, and is responsible for constructing and maintaining the multimodal transportation system in the state of Oregon. The mission of ODOT, as stated on

its website, is "to provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians" (ODOT 2016). To achieve this mission, ODOT has developed the following goals, which are published on its website (ODOT 2016):

- Safety - Engineering, educating, and enforcing a safe transportation system
- Mobility - Keeping people and the economy moving
- Preservation - Preserving and maintaining infrastructure
- Sustainability - Sustaining the environment and livable communities
- Stewardship - Maximizing value from transportation investments

As a large transportation agency with over 4,500 employees, ODOT has a series of diverse public service roles within the state. The agency is divided into nine separate divisions that each serve a role in achieving the mission of the organization. The divisions, which correspond to the different transportation systems the agency oversees, are as follows (ODOT 2012):

- Central Services Division
- Communications Division
- Driver and Motor Vehicle Services Division
- Transportation Development Division
- Public Transit Division
- Rail Division
- Motor Carrier Transportation Division
- Transportation Safety Division
- Highway Division

The abundance of divisions performing various tasks indicates the level of responsibility entrusted to this agency. The largest of these divisions, the Highway Division, is responsible for maintaining over 8,000 miles of roads and 2,700 bridges. In the 2010-2011 construction and maintenance season, almost $350 million of project funds were awarded for 145 projects around the state (ODOT 2012). These projects require that ODOT personnel be active in highway work sites. In total, it is estimated that 30-40% of ODOT's 4,500 employees are regularly in construction or maintenance work sites.

5.5.2 Oregon Work Zone Executive Strategy Steering Committee

One of the more visible and unique aspects of Oregon's safety program relating to highway work zones is the OWZESSC. This committee, which was established in December 2013, is an initiative to focus on improving work zone safety by potentially adjusting work zone policy in Oregon. One of the motivations for this committee was a 2013 construction contractor fatality in a work zone. This event sparked discussion among transportation officials for how to more safely enable vehicles to move (particularly heavy vehicles and commercial loads) through work zones.

The OWZESSC was designed to have a partnership with state agencies and private organizations that all have an interest in work zone safety. The committee currently has representation by officials from the following six groups:

- Oregon Department of Transportation (ODOT)
- Oregon Trucking Association, Inc. (OTA)
- Associated General Contractors, Oregon Columbia Chapter (AGC)
- Oregon State University (OSU)

- American Automobile Association (AAA)
- Oregon State Police (OSP)

Three task forces and one Resource Team were established amongst the committee members to address specific identified needs. The task forces are: Separation and Mobility, Law Enforcement, Engineering Enhancements, and a Communications Resource Team. Each task force is responsible for developing and proposing ideas for improving work zone safety. The ideas are presented at committee meetings for discussion by the full committee. Those ideas found to be promising are further developed and implemented.

The committee is not "owned" by any one of the partner organizations, though it is generally hosted by ODOT. Members from each of the six partner groups meet semiannually to discuss priority work zone safety issues establish statewide policy and goals for improving the safety in highway work zones. The committee then disseminates its initiatives to the various agency and organizational partners to communicate the changes to the individuals who work in or around work zones on a regular basis.

5.5.3 Model Structure and Data Sources

While the OWZESSC is effective at mobilizing the leadership of the involved partners and working to promote work zone safety throughout the state of Oregon, this initiative is less data driven than some in that Oregon's work zone fatal and serious injury crashes have decreased over the last ten years, or so. There was also data available with regard to similar committees during the implementation process to serve as a model for how to structure an effective committee.

Various officials with an interest in work zones and work zone safety saw an opportunity for an inter-agency partnership dedicated to work zone issues. In the development of this committee, there were several models of existing committees that had the desired structure of the proposed OWZESSC. In Oregon, existing Governor's Advisory Committees (GACs) focus on aspects of transportation safety like motorcycle safety and driving under the influence of intoxicants (DUII). These committees, unlike the OWZESSC, are established through Executive Order by the Governor of Oregon. However, the multi-agency elements of these committees served as an example to the OWZESSC partners of the structure of diverse task-force style committee. In addition, Washington State had a similar multidisciplinary committee that dealt with issues relating to work zone safety. These existing committees served as the basis for the structure of the OWZESSC.

5.5.4 Monitoring and Evaluation

Given the nature of an executive committee, there are few tangible metrics to monitor and evaluate its function and effectiveness. However, in order for the committee to remain effective, it will continue to conduct its regular semiannual meetings. Continuing participation of all six of the groups is necessary for its effectiveness. For the committee to be successful, active contribution from each of the partners is critical to maintaining a balanced and focused effort at improving safety in Oregon's work zones.

The volume of communication distributed from the committee as a result of the regular meetings is another method of monitoring the committee's activities. A newsletter is distributed after the quarterly meetings to highlight the committee's activities and promote the initiatives being discussed. One particular article

discusses how the OWZESSC is working to balance mobility within a work zone and the safety of the workers and the travelling public. In addition, the article highlights the engineering efforts being undertaken to improve work zones. This newsletter, and others like it, are a reminder to the employees of the involved groups of the work being done to improve worker safety in work zones (ODOT 2015).

5.5.5 Effectiveness of Safety Programs, Policies, and Practices

Since the OWZESSC has only been in place for a few years, it is perhaps too early to determine if the committee will be an effective long term force at improving safety in highway work sites. However, there are some indications that the committee's presence is currently having a positive effect on work sites. An ODOT safety official indicated that one of the effects of the committee has been a "real heightened awareness about the importance of safety in those settings [like] ODOT construction work [and] ODOT projects that are being constructed by contractors." Part of this increased awareness is the result of communication efforts from the OWZESSC.

The newsletter that is distributed to the ODOT employees that contains information about the committee's activities is distributed electronically and posted on bulletin boards for those employees who do not have regular computer access. In addition to this newsletter, there is regular email communication from the ODOT Director and the Highway Division Administrator regarding the safety initiatives at ODOT, including safety initiatives relating to highway work sites. Through these means, the activities of the upper management of ODOT are effectively distributed to the entire agency, and ensure the maintenance of an active safety culture at the agency.

Another aspect demonstrating the effectiveness of the committee is the education and promotion aspects of the committee. One of ODOT's construction managers has prepared a presentation on the OWZESSC, and has delivered this presentation to various groups within ODOT and outside of the agency to promote the activities of the committee and educate people about the efforts the committee has made to improve work site safety and mobility.

5.5.6 Recommendations for Safety Programs, Policies, and Practices

The implementation of a committee with the highest officials from various organizations and agencies around ODOT is a powerful tool to promote work site safety from the top-down in Oregon. The following points highlight some of ODOTs recommended policies and practices regarding the implementation of safety initiatives like the OWZESSC:

- Create partnerships and relationships with both public agencies and private organizations to work cooperatively to achieve mutual goals
- Effective communication and coordination from the state DOT top management to the rest of the members of the agency is vital for the success and support of a safety initiative
- Directly involving the upper management in the efforts to improve work site safety allows the agency leadership to directly invest in this important issue

5.6 State: South Carolina

5.6.1 DOT Size and Description

The South Carolina Department of Transportation (SCDOT) is responsible for the operation and maintenance of the fourth largest state-maintained highway system in the nation, including more than 41,000 miles of roadway and 8,400 bridges. SCDOT has approximately 4,350 employees, thousands of whom serve in the maintenance and construction divisions and work in both stationary and moving work zones on a daily basis; there are also numerous contractor personnel in both stationary and moving work zones on a daily basis. The statutory mission of SCDOT is described, "SCDOT shall have as its functions and purposes the systematic planning, construction, maintenance, and operation of the state highway system and the development of a statewide intermodal and freight system…the goal of the department is to provide adequate, safe, and efficient transportation services for the movement of people and goods" (SCDOT 2016).

5.6.2 27 in 7 Program

In 1999, SCDOT initiated an extremely aggressive and innovative program to complete 27 years' worth of construction and maintenance projects in only seven years. SCDOT contracted with two construction and resource management (CRM) firms to implement the program. This was the largest of this type of public-private partnership in the United States at the time (FHWA 2016e). It was estimated that the 27 in 7 program would increase the number of construction and maintenance work zones by up to 400%. SCDOT was concerned about the safety of its employees in these additional construction and maintenance work zones, as well as the safety of the motoring public. This concern prompted an

aggressive work zone safety initiative. This rapid increase in the number of construction and maintenance work sites in the state made it necessary to develop a program that was data-driven and was able to adjust itself quickly based on timely analysis of the available data. Therefore, the foundation of the initiative was a database that could be cross-referenced and could produce reports on a timely basis. This allowed SCDOT safety officials to see what the data was showing so they could modify implementation efforts to meet the agency's strategic plan and the Safety Office's business plan goals and objectives.

5.6.3 Let 'em work, Let 'em live High Visibility Work Zone Safety Enforcement Campaign

As an element of improving work site safety during the 27 in 7 program, an aggressive, high-visibility statewide Public Information and Education (PI&E) campaign was undertaken to promote safe driving in construction and maintenance work sites. When SCDOT developed the PI&E campaign, the first focus group was comprised of SCDOT highway workers. The major concern expressed by the highway workers was that, "drivers were flying through the work zones…we are so scared we were going to get killed because people ignore the signs to slow down…they act like nobody is even there, they are not paying attention". This suggested a high degree of concern by SCDOT highway workers. Conversely, when the motoring public was interviewed in focus groups, nobody thought there was a problem within work sites. Based on those two polar opposite beliefs, a campaign was created to put the public in the place of highway workers.

The overarching PI&E campaign slogan was, "Let 'em work, Let'em live". The campaign involved high quality television public service announcements, radio ads, billboards, brochures, citation holders, and other materials. The television

ads were the central focus of the campaign. They were highly creative and often put the motorist in the place of the highway worker, using some highly complex video graphics techniques. Some ads told the stories of workers killed in in work zone crashes; others told the real life stories of motorists killed in work zone crashes. The total campaign included a series of different ads, with messaging updated and changed to address what the data and campaign research information was showing at the time. The PI&E campaign was created, evaluated, and adjusted based on yearly focus groups conducted in different locations in the state; a statewide random digit dialing survey of a representative sample of motorists; and findings from an annual report of work zone safety statistics, compared with previous years' data. Overall, findings indicated the campaign was well received by South Carolina residents and had a significant impact on perceptions and self-reported behavior by motorists travelling through work sites (Topline 2004). During the active campaign, 32 other states adopted elements of the SCDOT work zone safety campaign.

5.6.4 Safety Record Competition

In addition to educating the public about the safety issues in work sites, the state also encouraged safe behavior among its employees. An annual safety record competition was held between all the counties in each of the agency's seven highway districts. The county with the best safety record was recognized during a luncheon where the agency director served as the keynote speaker. Additionally, the State Highway Engineer and the Director of the Safety Office would speak and present an award to the winning county. Also as a part of the incentive program, the employees of the winning county would receive a special cash bonus. The structure of the award, bonus, and recognition program helped promote friendly competition to raise safety performance. This initiative was

meant to ensure a balanced safety approach that took advantage of various opportunities and constituencies to improve safety for highway workers and the traveling public.

5.6.5 Data Sources, Archiving, and Analysis

SCDOT used various sources of data for its specific safety initiatives. SCDOT leveraged traffic collision data, compiled first reports of injury, collected lost work day case information, computed the lost work day case rates, calculated the actual economic cost from the first report of injury and crash data as appropriate, and calculated the actual amount of pay outs from the lost work day cases, as well as the estimated losses from the collision data. This information was compiled from data sets provided bi-monthly through the state's Traffic Collision Database (operated by the SC Department of Public Safety). The Crash Outcomes Data Evaluation System (CODES) (operated by the SC Office of Research and Statistics, SC Budget and Control Board), and the SCDOT Risk Management Database (administered by the SCDOT Safety Office, which included Risk Management, Claims, and OSHA units). SCDOT employees developed the Risk Management Database internally without benchmarking against other state DOT practices at that time. Beyond these databases, SCDOT also conducted focus group studies to collect public perception data on the PI&E work zone safety campaign that was being conducted. The collection and management of these data sources contributed to SCDOT's ability to improve highway worker safety in the state.

5.6.6 Monitoring and Evaluation

Given the fast pace of the 27 in 7 program and the subsequent safety initiatives developed as a result of the increased volume of construction and maintenance

sites, the ability to effectively monitor and quickly evaluate the current effectiveness of the programs was critical to the safety of the increased number of state employees and contractor personnel working in highway work sites. The safety officials believed that data-driven monitoring, which would give greater justification for decisions, would be the most effective for their evaluating their safety programs.

The development of a comprehensive set of cross-referenced databases allowed for accurate quantification of work zone related crash statistics, and the identification of causal relationships. An example of data analysis between 2004 and 2008 shows that there were 5,444 traffic crashes in South Carolina that were work zone related. In total, 56 people died in these crashes and an additional 2,296 sustained non-fatal injuries. The leading probable cause for work zone related crashes during 2004 – 2008, was "Driving too Fast for Conditions" with 1,585. The next five leading causes were: "Failure to Yield Right of Way" (834); "Driver; Inattention" (626); "Following too Closely" (540); "Improper Lane Change" (386); and "Driver Disregarding; Sign or Signal" (229) [SCDOT n.d.]. By being able to quantify the incidents that occurred in work sites, SCDOT could understand the circumstances that resulted in incidents and be able to effectively implement targeted responses to reduce the leading types of incidents.

To properly evaluate the PI&E work zone safety enforcement campaign, SCDOT needed to know if what the motoring public thought about work zones was changing as a result of the campaign. Survey research data collected before and during the PI&E campaign was used to evaluate the campaigns. SCDOT used computer generator random digit dialing to contact the public and take them through a survey process regarding their perceptions on work sites and specifically safety in work zones. Additionally, SCDOT conducted focus groups

in three different geographic regions of the state on an annual basis. Reports documenting the findings of the survey and focus groups were reviewed annually with Safety Office leadership and the research consultants. The reports from the focus groups summarize the results of both the qualitative and quantitative findings from the focus groups regarding their views on the television ads SCDOT had been airing. This information was presented at the leadership meetings and was used to determine how the messaging could be adjusted in the coming year to maximize the likelihood that particular incident outcomes and perspectives could be improved.

5.6.7 Effectiveness of Safety Programs, Policies, and Practices

Through activities like the development of the comprehensive Risk Management Database, the development of high visibility PI&E campaigns, extensive work zone safety training for SCDOT and contractor employees, and the improvement of the safety culture across the agency, SCDOT was able to use data to show its loss history and use the SCDOT strategic plan and the Safety Office's associated business plan to demonstrate improvements in safety performance. Ultimately, the demonstration of reductions in serious injuries and fatalities and the presentation of the agency's comprehensive Work Zone Safety Program provided evidence to negotiate lower rates and lower insurance premiums. This demonstration was only possible because of SCDOT being able to show its loss history and demonstrate the comprehensive approach that was being undertaken to bring down employee injuries and fatalities.

For the steps that SCDOT took in the aftermath of an incident involving an employee in a work site, some of the steps were regarded as particularly effective at contributing to the success of the agency's safety program. These include

thoroughly preparing the initial incident report, entering the information into the Risk Management Database in a timely manner, informing the appropriate OSHA office, and implementing a return to work initiative. Periodic safety data trend reports were also issued to District Engineering Administrators, senior staff, and headquarters and district safety personnel, showing both statewide and district statistics. Monthly briefings were held with headquarters and district safety personnel; these briefings included reviews of up-to-date data reports, discussions of specific injuries reported, and recommendations for methods to reduce or eliminate these types of incidents in the future. In addition, the reporting of "lessons learned" to senior management and providing recommendations for changes in policy based on the incident to prevent similar future incidents was seen by SCDOT as particularly valuable.

SCDOT's "Let'em Work, Let'em Live" Work Zone Safety Program was one of the winners of the FHWA 2007 National Roadway Safety Awards. The program also received a national award from the American Road and Transportation Builders Association (ARTBA) in 2005. Data collected during the implementation period showed (SCDOT 2007):

- Employee injuries dropped by 30.44%, from 657 in 2000 to 457 in 2007.
- There was a 30.26% reduction in OSHA recordable cases, from 489 in 2000 to 341 in 2007.
- The OSHA Incidence Rate (average number of recordable injury cases per 200,000 hours worked) decreased from 9.61 in 2000 to 6.68 in 2007, a 30.48% decrease.

- The Lost Workday Cases decreased by 47%, from 268 in 2000 to 142 in 2007, the lowest lost time injuries in 18 years.

- The Lost Workday Case Rate (number of Lost Workday Cases times 200,000 divided by number of man-hours worked) dropped from 5.27 in 2000 to 2.78 in 2007, a 47.24% reduction.

- During blitz enforcement periods, there was a 41.3% reduction in work zone crashes; a 40.9% reduction in work zone injuries, and a 52.2% reduction in work zone fatalities.

5.6.8 Recommendations for Safety Programs, Policies, and Practices

The increased exposure of SCDOT employees to the hazards of work zones from the 27 in 7 construction and maintenance program necessitated dramatic advancement in the safety program of SCDOT. A multifaceted approach including the development of several robust databases, an aggressive PI&E campaign, and shifts in the safety culture, all contributed to improved work zone safety performance in South Carolina. For SCDOT, the following recommended practices increase the possibility of having a successful safety program:

- High quality cross-referenced data is critical for being able to identify safety problems, develop mitigation strategies, and evaluate the impact of safety initiatives
- Positively influencing the perceptions and behaviors of the motoring public is a vital component of a comprehensive work zone safety initiative
- The implementation of a comprehensive work zone safety training program for highway workers, work zone supervisors, flaggers, and

contractor personnel that operates in conjunction with other components of the overall program

- The importance of a robust safety culture in the state agency is a critical component of a robust work zone safety initiative and its value cannot be underestimated

5.7 State: Virginia

5.7.1 DOT Size and Description

The Virginia Department of Transportation (VDOT) is responsible for building, maintaining and operating the state's roads, bridges, and tunnels (VDOT 2016a). VDOT also provides funding for airports, seaports, rail and public transportation (VDOT 2016a). VDOT operates the third largest state-maintained highway system (57,867 miles) in the country, just behind North Carolina and Texas. VDOT, in terms of lane miles, is one of the larger state DOTs included as a candidate case study (VDOT 2016b). Additionally, VDOT has approximately 7,500 full time employees across the agency, 80% to 90% of which are regularly out on construction sites.

According to the VDOT mission statement (VDOT 2016c), "Our mission is to plan, deliver, operate and maintain a transportation system that is safe, enables easy movement of people and goods, enhances economy and improves our quality of life." With respect to safety, the second bullet of the shared values in its public service statement indicates that VDOT employee's, "Commit to safety and continuous improvement in everything we do, learning from mistakes and successes alike (VDOT 2016c)."

Two highway worker safety programs were identified for inclusion in this case study, the VDOT Worker's Memorial and the Safety First Program. Both are detailed in the following subsections.

5.7.2 VDOT Workers' Memorial

The purpose of the VDOT Workers' Memorial is to honor state highway workers who died while performing their professional duties. Figure 5.2 shows a photograph of the memorial taken in the Fall of 2013. Specifically, it is "a place where family members, friends, and colleagues can reflect on their loss and where the traveling public can become more aware of sacrifices made by state highway transportation workers (VDOT 2016d)." The monument was dedicated on September 17, 2004 and was self-funded by $172,000 in contributions by VDOT employees and retirees, family members and businesses and organizations throughout the state (VDOT 2016e). The names of 133 employees who died between 1928 and 2012 are engraved on the memorial (VDOT 2016e). Many of these deaths occurred in work zone incidents (VDOT 2016e). The VDOT Workers' Memorial is located off Interstate 64 on Afton Mountain, about 25 miles west of Charlottesville. It is located in within a scenic overlook and provides visitors a picturesque setting to experience the monument.

Figure 5.2 VDOT Workers' Memorial (*Courtesy*: Jamie Johnston)

The memorial contributes to VDOT's overall safety program by helping to create and maintain awareness and a caring culture surrounding highway worker safety within the state. Those who visit the memorial, and those who see the memorial as they pass by on the highway, are reminded of the fallen workers and the impacts that crashes can have on human lives, and take away a reminder to drive responsibly. Contributing to driver behavior and societal culture in this way is supported by occupational safety and health management theories that recognize behavior and culture as significant components of enhancing occupational safety and health. The memorial addresses behavior and culture for not only the VDOT employees who view the memorial and continue to go out on highway worksites, but also for the travelling public.

5.7.3 Safety First Program

At VDOT, "Safety First" means integrating safety into the 24/7/365 delivery of each and every operation or job. Every employee and manager embraces the fundamental belief that the agency cannot fulfill its mission without the safety of the workforce being its foremost consideration. Therefore, the annual performance review for every employee and manager includes the safety of the workforce as a major component. By holding both employees and managers accountable in their annual work evaluations, the safety of the workforce is actively considered at all levels of the agency. This safety accountability has extended from technicians in the field all the way to district administrators being held accountable for the performance of their districts, divisions, and sections. This accountability is no longer exclusively related to roadway accidents, but now includes employee's accidents.

In fact, the first item on all VDOT personnel work evaluation forms is a safety assessment question. Every employee is expected to routinely demonstrate safety behaviors as well as advocate and practice safety in everyday work activities. Every Manager assumes responsibility to ensure a safe and healthy work environment, demonstrate and routinely practice safety behaviors and conditions of employment, and report all safety accidents and incidents and/or concerns appropriately in a timely manner.

To supplement the Safety First Program a safety process has also been implemented. The safety process is an initiative to change the culture through considering beliefs, practices, and attitudes of the agency, emphasizing that safety is a 24 hours a day and seven days a week endeavor. One aspect of

moving safety forward is to praise good choices and practices as they occur, not just to harp on negative observations.

VDOT's Safety First Program was initially developed in 2007 and represents a collaboration between the safety and health division and the human resources division. During the development process, safety programs in NCDOT, TxDOT, and other states were reviewed for benchmarking. Additionally, ASCE professional journals, national safety council publications, and other behavior based resources were reviewed to help arrive at language for the program that was readily identifiable and relatable for all personnel. The program was implemented in full scale in 2008.

5.7.4 Data Sources, Archiving, and Analysis

The Safety First Program necessitates the need for a wide variety of safety data beyond the requirements of OSHA reporting. Those additional data sources include, workers' compensation data, in particular the cost of the workers' compensation insurance premiums, and the number of lost work days due to injuries. Since the 2008 implementation, data collection comes to the forefront of the state's safety assessment. These data sources collected and archived by VDOT's statewide Safety, Security and Emergency Management department.

5.7.5 Effectiveness of Safety Programs, Policies, and Practices

The Safety First Program has upended safety analysis and considerations throughout the agency. The implementation of the Safety First Program has generated a positive result for VDOT personnel as the number of injuries have been reduced since 2008, however as with any real world implementation it is

difficult to isolate the effect of the Safety First Program on this trend. Anecdotally, one VDOT employee stated that there are, "Not as many names going up on our monument, let's put it that way and I'm glad to see that". This statement also lends credence to the effectiveness of the monument as a safety tool in Virginia. The monument is not only a reminder of the importance of safety within the agency, but also educates the travelling public about the risks accepted by those who serve the Commonwealth through the construction and maintenance of the transportation network.

5.7.6 Recommendations for Safety Programs, Policies, and Practices

The shift of transportation work safety from an ancillary consideration to a core responsibility of all personnel has been a meaningful and positive shift. For VDOT, a few of the program elements that contributed to the success of Safety First include:

- The active participation and accountability of management personnel through annual work evaluations
- They synergy of trying to address agency wide beliefs, practices and attitudes to substantively shift the culture of the organization towards making safety a core responsibility

5.8 State: Washington

5.8.1 DOT Size and Description

The Washington State Department of Transportation (WSDOT) oversees the state's multimodal transportation system, ensuring that people and goods move safely and efficiently (WSDOT 2016a). WSDOT is responsible for building, maintaining, and operating the state's highway system along with the state's

ferry system. The agency works in partnership with other agencies (local, state, and federal) to maintain and improve local roads, railroads, and airports. WSDOT also supports alternatives to driving such as public transportation, bicycles, and pedestrian programs (WSDOT 2016a).

The size of WSDOT and the state's transportation network can be illustrated using various metrics. The following metrics are reported on its website (WSDOT 2016a):

- Operates and maintains approximately 18,000 lane miles of state highways
- Owns, operates and maintains more than 3,600 bridge structures.
- Runs the largest ferry system in the nation that moves 22.4 million passengers and 10 million vehicles a year.
- Partners with 32 public transportation systems to provide more than 220 million passenger trips a year
- Owns three Talgo train sets in the Amtrak Cascades fleet and manages the Palouse River and Coulee City Rail system.

In addition, WSDOT has approximately 7,000 – 8,000 employees throughout the agency, 60-70% of which are regularly out on construction and maintenance sites.

According to its strategic plan (WSDOT 2016b), WSDOT's mission is to provide and support "safe, reliable and cost-effective transportation options to improve livable communities and economic vitality for people and businesses." With respect to safety, one of WSDOT's values is to "Promote the safety of the public and employees at all times." WSDOT has six agency goals, one of which, Goal 2 – Modal Integration, specifically addresses safety. A priority outcome for Goal 2 is to "Reduce number of fatal and serious injuries for all transportation modes."

The multimodal safety strategy specified to attain this outcome is to "Align multimodal safety policy-making across the agency" (WSDOT 2016b).

5.8.2 Near Miss Reporting Program

WSDOT added an innovative near miss reporting component to its safety program within the past year. Modeled after a similar program developed by one of WSDOT's construction contractors, the near miss program aims to both record near misses and generate ideas for eliminating the hazards that contributed to the near misses. No specific research was conducted by WSDOT to develop the program besides soliciting information about the contractor's program. Development of the program was also informed by those safety personnel within WSDOT based on their regular reading of articles on worker safety and new approaches to improving safety.

The near miss program is designed to encourage employees to provide information about near misses that they experience and suggestions for preventing the near misses in the future. This program is not the same as that used for incidents resulting in an injury or fatality. The program was initially developed within a WSDOT region. The value of the program was recognized by WSDOT leadership personnel, who directed the expansion of the program statewide. The support provided by WSDOT leadership personnel is viewed as a significant contribution to its success. Currently the near miss program is implemented on all major projects in the state.

The near miss program has several parts. Employees who experience or witness a near miss are encouraged to provide a simple report containing a brief written description of the near miss, a description of the immediate actions taken to eliminate the hazard or mitigate the safety risk, and suggestions for preventing a

near miss or injury in the future. The employee then gives the report to his/her supervisor. The supervisor reviews the report, works with the employee to identify solutions, and communicates the information recorded to the safety personnel for further review and analysis. In addition, the supervisor places the employee's name in a lottery for a drawing to win money or an item of some monetary value.

To enable communicating the details of the program and encourage implementing it in the field, WSDOT created a booklet that describes the program and provides guidance and forms for the workers. The instruction pages for the booklet are included in Appendix H. As shown in the figures, the booklet contains a definition of a near miss, a graphic depicting the frequency with which near misses occur relative to injury incidents of various severity (first aid only, recordable injury, serious injury, and fatality), and a list of safety strategy elements for preventing near misses. The safety strategy elements are: Commitment to Excellence, Employee Driven Culture, Basics Done Well, Focus on Greatest Potential Improvements, and Leadership Support and Accountability.

To further educate employees on safety management practices, the booklet additionally presents five core functions of organizational risk management. The five core functions are: (1) Define the Scope of Work; (2) Analyze the Hazards; (3) Develop and Implement Hazard Controls; (4) Perform Work within Hazard Controls; and (5) Provide Feedback and Continuous Improvement. Safety risk management includes consideration of frequency and severity of injuries, which are described in the booklet as well. Those using the booklet are presented definitions of low and high frequency and severity. The users are also asked to rate the frequency and potential injury severity of the near miss being reported.

To assist with the implementation process, the booklet includes a list of the steps associated with filling out a near miss report. Three steps are described as follows:

1. Submit a near miss or a safety suggestion to supervisor
2. The supervisor works with employee to identify solutions
3. Solutions may be implemented locally, regionally, or statewide

The booklet is pocket-sized, approximately 3" x 5", for ease of use and transport. The booklet was created with the assistance of the personnel in the graphics department within WSDOT. It contains about 20 pages, including pages on which near misses can be recorded. The Near-Miss or Safety Suggestion Report Form has fields where the employee can record his/her name, the date and time, WSDOT organizational name and unit number, whether the incident involved personnel and/or equipment, a description of the near miss incident and immediate actions taken, and suggestions for preventing a similar occurrence of the incident in the future. The report form usually takes no more than about two minutes to fill out. After completing the report form, the employee gives the form to his/her supervisor. WSDOT is currently in the process of developing an online application that can be used instead of the report form.

As mentioned previously, the near miss program was developed within one region and then diffused statewide with the assistance of WSDOT leadership personnel. Announcements about the program were first sent to key construction and maintenance personnel in each region. Promotional materials were also developed and provided to the regional personnel. The program was communicated during normally-scheduled, face-to-face meetings, and during safety meetings. The communications described the program, how to use the

booklet, how to fill out the report forms, who to give the booklet to, and how the overall near miss program works.

To date, WSDOT has received about 35 near miss reports with suggestions from across the state. In the approximately 12 months since the near miss program started agency-wide, some units within WSDOT have submitted 4 – 8 reports, while only 1 report has been received from other units within the past year. The number of reports received is recognized as being impacted by the extent to which management personnel within a region enthusiastically supported the near miss program when it was rolled out. More near miss reports and suggestions have been received from employees in those regions where greater support for the program was provided by regional management.

In some areas within WSDOT, the safety risk to employees is not very high (e.g., for office staff). As a result, it is expected that some operational units will not have as many near misses, and therefore fewer near miss reports will be generated. WSDOT has seen this trend in near miss reports generated. However, the near miss program is disseminated and made available to all operational units within WSDOT.

Some issues of concern were brought up during development of the near miss program. Unlike private companies, in public organizations there is often sensitivity and reluctance to giving away money or gifts as incentives to employees. Care was to be taken to ensure that the incentive program was documented, fair/equitable, substantiated, and accessible by all employees. As a result, WSDOT elected to set the value of the lottery money/gift at $25. This was intended, in part, to limit concerns about excessive spending and fairness. However, it was recognized that $25 may not be enough to gain interest from

employees and encourage them to complete and submit the near miss report, especially if their name just goes into a lottery and they may not receive the award. The low value may also be viewed as paltry. As a result, in some cases, regional personnel have felt that the amount is too low to give out, and decided not to implement the incentive part of the program.

WSDOT representatives believe that replication of the near miss program in other states is definitely possible. A state agency would simply need to develop the guidance and reporting forms, and then diffuse the program through the agency. In addition, administrative capabilities must be in place to administer the incentive part of the program, and collect and disseminate the lessons learned. According to WSDOT, states should be aware that there needs to be a balance between the number of near miss suggestions submitted and the incentive award. The near miss suggestions that qualify for including the employee's name in the lottery must be actionable and feasible. A suggestion that does not have a reasonable possibility of being implemented would not qualify the person to potentially win the incentive lottery award. However, in WSDOT's program, all suggestions were considered because there may be some way that the agency could benefit from the suggestion.

5.8.3 Data Sources, Archiving, and Analysis

As mentioned above, WSDOT's safety program includes the preparation of a report following an injury incident. When created, the reports are archived in an online database and also as a paper copy. Incidents are organized and tracked according to the following pieces of information: employee functional area, type of injury, time of day, and organizational unit. Data commonly used in analyzing the incident and evaluating the safety program comes from the following

sources: incident report, police citation report, worker insurance claim, safety training records, medical records, fatality/injury data, roadway design, and roadway design features. The data that is used becomes available within one month of the incident. Currently, WSDOT does not integrate this incident data to facilitate programmatic decision making.

In some cases, WSDOT uses incident data as support information to develop policies and practices. The following are examples of documents and programs which WSDOT developed in part based on incident data: additional training for workers, additional training for supervisors, new standards for work site traffic control plans, driver awareness programs, worker behavior assessment programs, safety incentive programs, and drug/alcohol abuse programs.

5.8.4 Monitoring and Evaluation

Monitoring and evaluation of the near miss program is part of WSDOT's administration of the program. Initial development included piloting the program in a few regions within the state. Since that time, the regions have implemented the program at their own pace. WSDOT has found that new programs like the near miss program require internal marketing and "salesmanship" to motivate and support the regions to implement the program. In addition, endorsement from supervisors and managers is required. At first the implementation may be spotty and inconsistent. Time is required to get the program effectively in place agency-wide. Additionally, resources are needed to ensure that it is implemented consistently from region-to-region.

The success of the near miss program will ultimately be measured by the number of near misses, and worker injuries, that occur in future years. These are lagging indicators of success. WSDOT also monitors leading indicators such as the

number of near miss reports received, the overall value of each suggestion for mitigating the near miss hazard. WSDOT has noticed that many of the initial suggestions are "low-hanging fruit." That is, the hazards identified and safety suggestions submitted are easy to spot and envision, and often site specific. Now WSDOT is looking for ideas that may have applicability to a broader range audience. To further enable implementation of the suggested practices, WSDOT is working to collect and present the information in such a way that it is applicable to other situations across the agency.

5.8.5 Effectiveness of Safety Programs, Policies, and Practices

Since the program was implemented approximately one year ago, there has not been a lot of time to determine the long term effectiveness. However, the expansion of the program from a regional to a state level indicates agency leadership buy-in to the program, which improves its chances of being effective. More data related to the number of near miss reports and suggestions submitted, and the immediate and long-term outcomes of the program, need to be documented and analyzed in order to determine the program's full extent success. Of all the safety management program elements employed by WSDOT, those practices that are viewed by the interviewee as having the greatest value to overall success of the agency's safety program are: preparing an initial incident report; conducting an incident review meeting; communicating the lessons learned agency-wide, reviewing or modifying policies and procedures following an incident; and conducting a post-incident investigation.

5.8.6 Recommendations for Safety Programs, Policies, and Practices

Safety management program success stems from multiple factors. These factors are both local to the employee and across the agency, and extend from the initial

development and roll out of the program to its continued implementation and monitoring. For WSDOT, the following recommended practices enhance the potential for success of a program:

- Having agency management personnel actively engaged around the safety effort
- Positive and continuous communications from top executives within the agency about the high priority of safety
- Engaging project and unit managers in the safety program, with the same or higher level of engagement from supervisors and employees
- Providing engaged, hands-on safety staff who continually strive to develop viable solutions to mitigate safety hazards
- Employing safety staff who have a solution-minded, collaborative approach and constructive working relationships with front-line supervisors and employees

5.9 Summary

The program elements that a state DOT implements that impact the safety of state DOT employees can be very diverse. This diversity contributes to a multi-faceted approach that is necessary to reduce the safety risk to highway workers. The seven case studies presented from California, Maine, North Dakota, Oregon, South Carolina, Virginia, and Washington demonstrate the diversity of programs available to state DOTs for their safety programs. The descriptions of these programs serve as examples to state DOTs of the processes, stakeholders, and data necessary to establish or modify safety programs in other state DOTs.

The seven case studies highlight the diversity of safety programs currently being implemented by state DOTs across the country. CalTrans has implemented a Design for Safety initiative encourages designers to consider the construction and maintenance safety issues for those implementing the projects. The safety idea incentive program in MaineDOT and the near miss program from WSDOT explore the potential of getting work crews themselves involved with the safety programs that directly affect them. Oregon's OWZESSC demonstrates an effort to get the administration of work site safety stakeholders together to keep work sites a highly visible safety issue statewide. Virginia has sought to make safety of its employees a publically visible issue through the construction of the VDOT Workers' Memorial. South Carolina used extensive public outreach and involvement to adjust and improve their safety program and educate the workers and public about the risks in work sites. Finally, NDDOT's leading indicator and return to work initiatives are tackling new forms of data to shift the culture of the safety program from reactionary to proactive. These programs demonstrate that data is not widely used in safety programs, and the data available may only impact part of an overall safety program.

There are limitations to the applicability of the findings presented in this chapter. Obviously, given that only narrowly focused elements of seven state DOT safety programs were explored in this chapter, there are likely many other innovative safety programs being implemented in state DOTs across the nation. In addition, the information for the case studies, in most cases, was only collected from one source within the agency.

Despite these limitations, this chapter retains significant value as a portion of the synthesis on current safety practices for highway workers. The chapter uniquely provides an "agency-level" view of safety programs from the individuals that

manage these programs on a daily basis. It demonstrates the details, challenges, and efforts that are required to maintain effective safety programs. This perspective is an excellent complement to the national trends of agency practice and perspective provided by the data analysis and survey results.

6 CONCLUSIONS

6.1 Discussion

Based on the scope of this Thesis to provide a review of current state DOT practice for documenting and promoting the safety of their highway workers, as well as a review of the literature, four research questions were developed to create a more comprehensive understanding of state DOT practice for highway worker safety. The methodology for this research paper, which included the use of a survey and case studies from state DOTs, was designed to address each of the research questions. The survey results (Chapter 4) and the state DOT case studies (Chapter 5) provide the detailed results from the research methodology.

The following paragraphs further discuss these results in the context of the initial research questions and provide general conclusions regarding the current state of state DOT practice for documenting and promoting the safety of highway workers. For clarity, each of the research questions are restated below and the discussion of the pertaining results follows.

Research Question #1: *How do state DOTs respond when an incident with a highway worker occurs in a work site?*

This research question sought to elicit information regarding incident reporting and data collection policies at state DOTs. While all state DOTs have the goal of preventing incidents in work sites, the reality is that incidents regularly occur across the country. The data that states collect can help them to inform and develop their highway worker safety programs. An entire section of questions regarding incident reporting was included in the survey questionnaire

distributed to the state DOTs. These questions included the basics of what steps are taken and what data is collected in the aftermath of an incident.

The most notable result from the types of steps taken by state DOTs after an incident was the consistency of the steps across the types of incidents. Whether the incident involved a public automobile, an on-site vehicle/equipment, or an on-site hazard, the state DOTs performed similar steps for each type of incident. One possible explanation for this is that DOTs are being constrained by Federal OSHA policy to conduct certain steps in the aftermath of any incident. However, there was significant variability in how many states implemented a certain step from the itemized list in the questionnaire. Some steps only were used by a few states, while others were employed by most states. This likely speaks to the variability among state safety policies which suggests a variety of approaches to state DOT highway worker safety programs. The inconsistency with which incidents are archived further suggests a diversity among the state DOTs. This might be related to the availability of technological resources. There are many DOTs that use combinations of on-line databases, electronic documentation, and paper copies to archive incident reports.

The "near miss" incident is not easily classified into the previously described incidents. Only 44% of the state DOT respondents have a system in place to report near miss incidents. In many cases, states that do not have an independent near miss reporting system use the standard incident reporting system. Under this system, it is likely that many near misses are not recorded under this system. According to the results, near misses are poorly defined, which could contribute to them being inconsistently recorded. The WSDOT and the MaineDOT case studies are both examples of programs that have tried to address the near miss problem and encourage reporting these types of incidents. By better

understanding near miss incidents and properly recording them, state DOTs have the opportunity to implement safety countermeasures in certain situations before there is an injury or fatality.

Research Question #2: *What is the current state of practice for using data to develop, implement, and evaluate state DOT worker safety programs?*

Data driven safety programs are an emerging area of practice and research, and this question served to explore how data is collected and used at state DOTs. There are many sources of data that are collected and stored by state DOTs. The available or accessible sources of data vary from state to state. However, not all of these accessible data sources are used. This is because many of the data sources are not complete, making it more difficult to base policies and programs off this data. States also do not frequently perform research and analysis on the existing data. Devoting resources to developing more complete data sets and associated analysis would make the existing data collected more valuable to state DOTs. Another benefit would be the sharing of state level data between different government agencies that are stakeholders in highway worker safety. Twenty-two percent of survey respondents indicated their agency does not share information or data with any other organization. There is a great potential to save resources through the sharing of data that can be mutually beneficial to safety policies and programs.

In addition, several of the case studies discuss more specific examples of data that is collected and used for individual safety programs. All of this information together provides a general understanding about data usage at state DOTs. In general, the case study findings suggest that data is not heavily relied upon for safety program development, implementation, or evaluation. While data is

collected as a result of the programs implemented, data is rarely used to inform and shape the creation of a safety program. The general attitude toward state DOT safety programs was that agencies implemented programs as experiments based on previous experience and available institutional resources. Encouraging state DOTs to use state and national level data when creating safety program elements could result in more focused programs that specifically target the unique safety issues present in each state.

Research Question #3: *Are there examples of current or recent data driven worker safety programs that have been implemented by state DOTs?*

It is important to explore general trends for data driven programs related to worker safety across the nation, but there is also a lack of specificity of what measures are being used at the state DOT level. The case studies explored specific safety programs that have been implemented at a state DOT. These safety programs have various scopes and focus on different topics addressing highway worker safety.

Through the case studies prepared for this Thesis, a variety of specific safety programs were analyzed. The descriptions of these programs, which are included in Chapter 5, detail how the programs are monitored and evaluated. For each case there are recommendations regarding some of the important steps and institutional foci required to implement it. The purpose of these recommendations is so other state DOTs could potentially implement elements of the programs at their own agencies. One of the reasons a diversity of state size was desired in collecting the case studies was to provide examples of safety programs that can be implemented with a range of available resources.

The programs varied in terms of how much data they used or collected. Some programs relied predominantly on qualitative data. The submitted safety ideas from the safety idea incentive program at MaineDOT, the JSA forms for the leading indicator initiative at NDDOT, and the near miss reporting program at WSDOT all collected data from forms and submissions that are a part of their respective programs. This data was used to better understand the overall safety culture at each agency and to evaluate the programs to ensure they are continuing to make DOT employees safer.

CalTrans' design for safety initiative and VDOT's safety first campaign both use qualitative data collected by the agency to inform its safety program. These data sources include fatality and injury incident data, insurance premiums, and workers' compensation information. In South Carolina, their *Let 'em Work, Let 'em Live* work zone safety enforcement campaign used both qualitative and quantitative data to continually adjust the program to improve worker safety. The qualitative data, which included focus groups, was used to adjust the public safety message and the quantitative data, in the form of accident statistics, was used to evaluate the success of the messaging. Others, like the OWZESSC in at the ODOT and the Workers' Memorial at VDOT, did not rely on data at all. Instead, these programs aim at changing the safety culture through administrative influence and public outreach.

These case studies provide examples of safety programs across the country. While the original focus of the case studies was data-driven safety programs, the research discovered that there are not that many programs that specifically rely on data. The case studies vary greatly in terms of data usage from South Carolina's program that constantly used data to refine its public campaign for work zone safety to the OWZESSC that had no data component. However, this

diversity describes that worker safety programs can, and should, come in all forms to provide a more comprehensive environment that helps to prevent worker injuries and fatalities.

Research Question #4: *How does the size and scope of a state DOT influence the agency's highway workers health and safety programs?*

The demographic questions in the survey such as the variation in the percentage of employees who are regularly on work sites and the variety of sizes of state DOTs in terms of number of employees confirms the assumption that state DOTs are diverse entities in size and scope. The case studies further confirmed this assumption from the breadth of types of safety programs that are implemented across state DOTs. However, the purpose of this research question was to explore what differences result in worker safety programs as a result of this institutional variability. The primary research mechanism for this was the matrix of survey questionnaire responses that categorized the state DOTs by size (in terms of total disbursements). The matrix highlighted some of the impacts that these institutional factors might have.

One of these differences was the speed that the DOTs had access to data after an incident. In general, the smallest DOTs had access to the information more quickly that larger DOTs. Having quick access to data provides more opportunity to adjust safety programs and policies when trends or anomalies are observed. Another difference was that the smallest DOTs were more likely to use data to implement driver awareness and drug/alcohol abuse programs. Even when considering just these questions, differences in the operation of state DOTs is apparent based on the size of the agency. Understanding these differences may allow a DOT of a particular size to better understand its intrinsic strengths and

weaknesses so that resources can be best allotted to maintain an effective overall safety program.

6.2 Limitations

While the data gathered from both the survey and the case studies was valuable in being able to answer the four research questions, the data from these two research tasks are subject to certain limitations based on the realities of the research process. By employing both a survey and case studies, this thesis minimizes the effects of the limitations by exploring the breadth and depth of the subject. However, these limitations are still important for understanding the consequence of the research.

The data from the survey yielded broad data from across the United States. However, since only 41 states responded to the survey, the results are not as robust as they could have been had all 50 states submitted a response to the survey. In addition, while several of the demographic questions regarding the respondent to the survey indicate that appropriately qualified individuals responded to the survey, the responses still reflect the knowledge and experience of the specific employee that responded to the survey on behalf of their state DOT. This could have led to some inaccurate responses to questions where the respondent did not know the answer. The respondents across the state DOTs held different roles within their agency. This variability could affect the perception of each state DOT's safety program based on the information known by the survey respondent.

The case studies provided the necessary specificity and detail to be able to best answer the research questions. This provided a necessary contrast to the survey data, but this research task has its own inherent limitations. The most important

is the limited scope of the programs. Only seven states were used for the case studies. The lack of breadth of this research task was offset by the depth to which each of the seven safety programs were explored. Like the survey, the case studies are based on the knowledge and experience of one or two employees at each respective state DOT. However, each of the employees interviewed was directly responsible or involved with the safety programs described in the case studies. Overall, the data collected for this thesis has certain limitations due to the structure of the research tasks. However, the data collected is still useful in answering the four research questions posed by this thesis.

6.3 Recommendations for Future Research Needs

There is an opportunity for future research to advance what is known about highway worker safety policies and practices within state DOTs. These recommendations for future research needs include, but are not limited to, the following:

- State DOTs could benefit from further research on how to utilize data to develop and implement a limited number of targeted safety programs for maximum impact rather than simply trying an overabundance of program elements that may not result in the same level of overall effectiveness.

- To assist state DOTs, further research is needed that establishes risk factors for highway workers based on worksite conditions and operations. The risk factors can then be used to design and manage work operations to minimize safety risk. This type of research could be conducted effectively utilizing experimental tools that simulate worker, driver, and equipment operator interaction in a safe, virtual environment.

- State DOTs require a framework for conducting quantitative evaluations of individual safety program elements. The framework would require a data dictionary to define relevant performance measures for particular types of program elements, guidance on how to structure the implementation for the purpose of increasing the validity of the evaluation, and a mechanism for determining the overall Return on Investment for a particular intervention.

- One critical aspect of highway worker safety is the safety culture of state DOTs. There is a need for a robust procedure to evaluate the safety culture of a state DOTs so that safety program elements aimed at improving safety culture can be objectively evaluated.

- The existing databases of national health and safety data that are collected and compiled by various agencies such as OSHA, BLS, etc. present various aspects of helpful information, but there is little integration of these data sets. New research should be conducted to determine ways that these data sources could be integrated to offer more detailed and flexible health and safety information to state DOTs. Additionally, efforts to improve usability and access to publicly available datasets (such as NCCI data) could be useful to state DOTs.

- The exploration of "near miss" incidents across state DOTs and establishing an easily understood standard definition could limit underreporting (or inconsistent reporting) of near miss incidents that occur in highway work sites.

- The state DOTs each have a unique structure based on the individual needs of that state. This diversity of structure could motivate future

research investigating how the organizational structure of a sate DOT leads to improved safety.

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APPENDICIES

APPENDIX A SURVEY QUESTIONNAIRE

Part 1: Demographics

NCHRP Topic 47-16
Survey Questionnaire - Highway Worker Safety

Highway worker safety is of utmost concern to state Departments of Transportation. However, there is little information on available data and best practices to eliminate or minimize highway worker incidents. This questionnaire is part of NCHRP Synthesis Topic 47-16 to gather information on state DOT perspectives on highway worker safety. We are interested in collecting information about reporting policies, data collection practices, and data utilization by agencies regarding incidents in work sites with highway workers employed by state DOTs. We are interested in the experience and opinions of agencies regardless of whether they have data, research, or programs that look at highway worker safety in work sites on roadways. The questionnaire has 23 questions, and you may be asked to complete only a subset of these based upon your agency's policies and procedures relating to highway worker safety. Trial use in a survey pre-test shows that the questionnaire can be completed within 30 minutes.
The following definitions are used in this questionnaire:

- **Incident**: An unplanned event or disruption to the work involving a highway worker employed by a state Department of Transportation (DOT) in a construction or maintenance work site that resulted in, or could have resulted in, an injury or fatality.

- **Near miss (near hit)**: An incident involving a highway worker employed by a state DOT in a construction or maintenance work site that did not result in an injury or fatality to the worker.

- **Highway Worker:** An employee of a state DOT that is active in construction or maintenance work sites. For the purpose of NCHRP Topic 47-16, this definition does not include employees of contractors working on state owned projects.

What is the name of the agency that you work for?

What is your job title or position at the agency?

How many years have you worked with your current agency?

What is the approximate size of your agency in total number of employees?

- <500
- 500-999
- 1000-1999
- 2000-3999
- 4000-6999
- 7000-9999
- 10000+

What is the approximate percentage of your agency's employees who are regularly on construction and/or maintenance sites?

- 0-10%
- 10-20%
- 20-30%
- 30-40%
- 40-50%
- 50-60%
- 60-70%
- 70-80%
- 80-90%
- 90-100%

How often do you work with worker injury claims and prevention programs?

- Very often (daily)
- Often (weekly)
- Sometimes (monthly)
- Rarely (several times a year)
- Very rarely (yearly)
- Never

What is your role with worker injury claims and prevention programs?

Part 2: Incident Reporting

If an injury or fatality incident involving a highway worker occurs in a work site on a roadway, what steps does your agency take to document and report the incident? Identify the steps taken for incidents involving public automobiles, on-site construction vehicles and equipment, and on-site hazards (incidents not involving a vehicle/equipment). Please check all that apply.

	Public Automobile	On-site Vehicle/Equipment	On-Site Hazard
Prepare initial incident report	☐	☐	☐
Prepare worker injury claim	☐	☐	☐
Inform law enforcement	☐	☐	☐
Inform insurance policy provider	☐	☐	☐
Inform Federal OSHA office	☐	☐	☐
Inform State OSHA office	☐	☐	☐
Conduct incident review meeting	☐	☐	☐
Upload findings to 'lessons learned' database	☐	☐	☐
Communicate 'lessons learned' agency-wide	☐	☐	☐
Return to work initiatives	☐	☐	☐
Review or modify policies and procedures	☐	☐	☐
Post-incident investigation	☐	☐	☐
Other	☐	☐	☐

The following table includes the post-incident steps you indicated that your agency takes. For each of the steps, please rate the effectiveness of each step according to its contribution to the success of your agency's safety program using a scale of 1 to 5 (1 = not effective, 5 = very effective).

	Public Automobile	On-Site Vehicle/Equipment	On-site Hazard
Prepare initial incident report	▼	▼	▼
Prepare worker injury claim	▼	▼	▼
Inform law enforcement	▼	▼	▼
Inform insurance policy provider	▼	▼	▼
Inform Federal OSHA office	▼	▼	▼
Inform State OSHA office	▼	▼	▼
Conduct incident review meeting	▼	▼	▼
Upload findings to 'lessons learned' database	▼	▼	▼
Communicate 'lessons learned' agency-wide	▼	▼	▼
Return to work initiatives	▼	▼	▼
Review or modify policies and procedures	▼	▼	▼
Post incident investigation	▼	▼	▼
Other	▼	▼	▼

Which department(s) at your agency has the responsibility of compiling and archiving the incident reports? Please check all that apply.

- ☐ Regional/District Human Resources
- ☐ Statewide Human Resources
- ☐ Regional/District Traffic Engineering
- ☐ Statewide Traffic Engineering
- ☐ Regional/District Maintenance Office
- ☐ Statewide Maintenance Office
- ☐ Regional/District Safety Office
- ☐ Statewide Safety Office
- ☐ Other (State Department)
- ☐ None

If incident reports are archived, what is the format of the archive? Please check all that apply.

- [ ] On-line database
- [ ] Electronic documentation (e.g., .pdf file)
- [ ] Paper copy
- [ ] No specified format
- [ ] Other

If incident reports are archived, how is the data categorized? Please check all that apply.

- [ ] Employee functional area
- [ ] Traffic volume
- [ ] Type of injury
- [ ] Severity of injury
- [ ] Functional classification of roadway
- [ ] Time of day
- [ ] Other

If a "near miss" incident occurs in a work site, is there a system to report these incidents within your agency?

- ( ) Yes
- ( ) No

Please briefly describe your agency's near miss reporting system.

For your agency's "near miss" reporting, is the process the same as for incidents resulting in an injury or fatality?

- ( ) Yes, the process is the same
- ( ) No, a separate process is used

Please briefly describe any differences in the process.

What is the reason why your agency does not have a reporting system for "near miss" incidences? Please check all that apply.

- ○ Lack of resources
- ○ Fear of inconsistent reporting
- ○ Lack of clear definition of "near miss"
- ○ No clear value of "near miss"
- ○ No clear need in recording incidences
- ○ Other
- ○ Unsure

Part 3: Data Collection

What highway worker health and safety data is available to your state DOT and what data is used by your state DOT? Please check all that apply. For data that is available, how complete is it (1 = very incomplete, 5 = very complete)

	Available	Used	How complete is the data?
Incident report	☐	☐	▼
Police citation report	☐	☐	▼
Worker insurance claim	☐	☐	▼
Worker annual performance review	☐	☐	▼
Safety training records	☐	☐	▼
Contractor safety records	☐	☐	▼
Medical record	☐	☐	▼
Fatality/injury data	☐	☐	▼
Roadway design	☐	☐	▼
Roadside design features	☐	☐	▼
Other	☐	☐	▼

For the data identified in the previous question as being used by your agency, is this data integrated to facilitate programmatic decision making, and if so, how?

How long after an incident is data available to your agency for review and analysis?

Incident report	
Police citation report	
Worker insurance claim	
Worker annual performance review	
Safety training records	
Contractor safety records	
Medical records	
Fatality/injury data	
Roadway design	
Roadside design features	
Other	

Are there any worker safety and health data sources that would be beneficial to your state DOT that you currently do not have or have access to?

- Yes
- No

Please briefly describe any data sources that would be beneficial.

Has your agency conducted any research or data analysis regarding highway worker safety in work sites on roadways and worker compensation related to injuries?

- Yes
- No

Please briefly describe the research or data analysis, and provide a link to the report(s), if available.

Part 4: Data Utilization

Has your agency used its own data or other data relating to highway worker safety to develop any of the following policies/practices for highway workers in work sites on roadways? Please check all that apply.

- ☐ Additional training for workers
- ☐ Additional training for supervisors
- ☐ New standards for work site traffic control plans
- ☐ Driver awareness programs
- ☐ Worker behavior assessment programs
- ☐ Safety incentive programs
- ☐ Drug/alcohol abuse programs
- ☐ None
- ☐ Other

Does your agency share incident data with other organizations regarding highway worker safety? If so, which organizations? Please check all that apply.

- ☐ Federal agencies
- ☐ State DOTs
- ☐ County/Municipal governments
- ☐ Private organizations
- ☐ None
- ☐ Other

In the space below, please briefly comment on recommendations you have for other transportation agencies regarding implementing and improving safety programs based on policies and practices that you believe have worked for your DOT and those that have not.

Part 5: Follow Up (Optional)

If you would be willing to participate in a short follow-up interview (approximately 15 minutes) to this survey, please provide the following contact information. Your additional responses will help us make the research more complete and better inform transportation agencies regarding best practices for highway worker safety.

Name	
Address (of workplace)	
Email address	
Phone number	

APPENDIX B TABULATED DATA FOR SELECTED SURVEY QUESTIONS

Table B1a Documentation Steps and Archival Categorization

	Steps taken (by type of incident) to document and report injury and fatality incidents, and perceived effectiveness of step toward the success of agency's safety program (1 = not effective, 5 = very effective)												**If incident reports are archived, how is data categorized? (Select all that apply)**						
Step	Communicate lessons learned agency-wide			Return to work initiative			Review or modify policies and procedures			Post-incident investigation			Employee functional area	Traffic volume	Injury type	Injury severity	Roadway functional classification	Time of day	Other
Type of Incident	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.							
A. State DOTs with <$1 billion in disbursements (2013)*																			
A1	5	5	5		2	2		3	3	5	5	5	X		X	X			X
A2	4	4	4				5	5	4	4	4		X		X	X			
A3	5	5	5	3	3	3	4	4	4	5	5	5	X		X	X		X	
A4	5	5	5	3	5	5	5	5	5	5	5	5	X		X	X	X	X	
A5		3	3		3	3		3	3		4	4	X		X	X	X		
A6								3	3		3		X		X	X	X	X	
A7	3			3			3			3			X						
A8																			X
A9	4	4	4				5	4	4										X
Avg.	**4.3**	**4.3**	**4.3**	**3.0**	**3.3**	**3.3**	**4.4**	**3.9**	**3.7**	**4.4**	**4.3**	**4.8**							
Count													**7**	**0**	**6**	**6**	**3**	**3**	**3**
Percent													**78%**	**0%**	**67%**	**67%**	**33%**	**33%**	**33%**

*Disbursement categories for all tables created from FHWA reported expenditure data (FHWA 2013b)

Table B1b Documentation Steps and Archival Categorization

	Steps taken (by type of incident) to document and report injury and fatality incidents, and perceived effectiveness of step toward the success of agency's safety program (1 = not effective, 5 = very effective)												**If incident reports are archived, how is data categorized? (Select all that apply)**						
Step	Communicate lessons learned agency-wide			Return to work initiative			Review or modify policies and procedures			Post-incident investigation			Employee functional area	Traffic volume	Injury type	Injury severity	Roadway functional classification	Time of day	Other
Type of Incident	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.							
B. State DOTs with $1-$2 billion in disbursements (2013)																			
B1		3	3		4	4		2	2		2	2	X		X				
B2				4	4	4				4	2	2	X		X	X			
B3		4	4		5	5		3	3		5	5			X	X			
B4				5	5	5	5	5	5	4	4	4	X		X				X
B5	1	4	4	1	5	5	2	5	5	1	3	3	X						X
B6																			X
B7	4	3	4		2	3	4	4	4	4	4	4	X		X	X	X	X	
B8		4	4		3	3		4	4		4	4	X		X	X	X	X	
B9	5	5	5	2	2	3	5	5	5	5	5	5			X				
B10				4	4	4	3	3	3	4	4	4	X						
B11	3	3	3				2	2	2	3	3	3	X		X	X			
B12							3	3	3								X		X
B13	4	5	5	5	5	5	1	3	4	1	4	4							X
Avg.	**3.4**	**3.9**	**4.0**	**3.5**	**3.9**	**4.1**	**3.1**	**3.5**	**3.6**	**3.3**	**3.6**	**3.6**							
Count													**8**	**0**	**8**	**5**	**3**	**2**	**5**
Percent													**62%**	**0%**	**62%**	**38%**	**23%**	**15%**	**38%**

Table B1c Documentation Steps and Archival Categorization

	Steps taken (by type of incident) to document and report injury and fatality incidents, and perceived effectiveness of step toward the success of agency's safety program (1 = not effective, 5 = very effective)												**If incident reports are archived, how is data categorized? (Select all that apply)**						
Step	Communicate lessons learned agency-wide			Return to work initiative			Review or modify policies and procedures			Post-incident investigation			Employee functional area	Traffic volume	Injury type	Injury severity	Roadway functional classification	Time of day	Other
Type of Incident	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.							
C. State DOTs with $2-$4 billion in disbursements (2013)																			
C1																			X
C2	4	4	4	4	4	4	4	4	4	4	4	4	X	X	X	X	X	X	
C3	5	5	5										X		X	X			X
C4							3	3	3	2	3	3			X	X		X	
C5	5	5	5	5	5	5	5	5	5	5	5	5	X		X	X	X	X	
C6	3	2	2				4	3	2	4	4	4			X				
C7		4	4		4	4		3	3		4	4	X						X
C8	4	4	4	5	5	5	4	4	4	3	3	3			X				
C9	5	4	2	5	5	5	4	4	2	4	4	2	X		X	X			
C10	2	3	3	3	4	4	2	2	2	2	3	3			X	X		X	
Avg.	**4.0**	**3.9**	**3.6**	**4.4**	**4.5**	**4.5**	**3.7**	**3.5**	**3.2**	**3.4**	**3.8**	**3.5**							
Count													**5**	**1**	**8**	**6**	**2**	**4**	**3**
Percent													**50%**	**10%**	**80%**	**60%**	**20%**	**40%**	**30%**

Table B1d Documentation Steps and Archival Categorization

	Steps taken (by type of incident) to document and report injury and fatality incidents, and perceived effectiveness of step toward the success of agency's safety program (1 = not effective, 5 = very effective)												**If incident reports are archived, how is data categorized? (Select all that apply)**						
Step	Communicate lessons learned agency-wide			Return to work initiative			Review or modify policies and procedures			Post-incident investigation			Employee functional area	Traffic volume	Injury type	Injury severity	Roadway functional classification	Time of day	Other
Type of Incident	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.	Public auto	On-site veh.	On-site haz.							
D. State DOTs with >$4 billion in disbursements (2013)																			
D1	4	4	2	2	2	1	5	5	5	5	5	5	X		X	X			X
D2		4	3		3	3		4	4		4	4							X
D3	5	5	5	5	5	5	4	4	4	4	4	4	X		X			X	
D4	4	4	4	3	4	4	4	4	4	4	4	4	X		X			X	X
D5															X	X			X
D6	4	4	4	2	2	2	4	4	4	4	4	4	X		X	X			X
D7					5														X
D8				4	4	4	4	4	3	5	4	3	X	X	X	X	X	X	X
D9													X		X		X	X	
Avg.	**4.3**	**4.2**	**3.6**	**3.2**	**3.6**	**3.2**	**4.2**	**4.2**	**4.0**	**4.4**	**4.2**	**4.0**							
Count													**6**	**1**	**7**	**4**	**2**	**4**	**7**
Percent													**67%**	**11%**	**78%**	**44%**	**22%**	**44%**	**78%**

Table B2a Near Miss Reporting Process

	Does the agency have a process to report near misses?		Reason for not having a process for reporting near misses						
State	Yes/No	Description of near miss reporting process	Lack of resources	Fear of inconsistent reporting	Lack of clear definition of "near miss"	No clear value of near miss	No clear need in recording near miss incidents	Other	Unsure
A. State DOTs with <$1 billion in disbursements (2013)									
A1	Y	Districts report a near miss on the same forms used to report injury/illnesses, and indicate injury as "non-reportable".							
A2	N				X				
A3	N					X			
A4	Y	All safety committees review and discuss near miss reports submitted.							
A5	N							X	
A6	Y	The process is the same process used for injuries. However, near miss reports may not be submitted unless agency management staff becomes aware of the near miss.							
A7	Y	Employees are encouraged to report all near misses.							
A8	N								X
A9	Y	Verbally and by email.							
Count	**Y [5] N [4]**				**1**	**1**		**1**	**1**

Table B2b Near Miss Reporting Process

	Does the agency have a process to report near misses?		Reason for not having a process for reporting near misses						
State	Yes/No	Description of near miss reporting process	Lack of resources	Fear of inconsistent reporting	Lack of clear definition of "near miss"	No clear value of near miss	No clear need in recording near miss incidents	Other	Unsure
B. State DOTs with $1-$2 billion in disbursements (2013)									
B1	Y	An incident report form is used. Separate near miss report forms have been developed by three different offices within the agency.							
B2	N				X				
B3	Y	The employee who witnessed or experienced the near miss fills out and submits a form to the safety office. The completed forms are periodically reviewed and discussed by the safety staff within the region to identify and develop solutions. The solutions are then communicated back to all employees.							
B4	N								X
B5	N				X				
B6	N							X	
B7	Y	Included within the standard incident reporting process.							
B8	N				X				
B9	N						X		
B10	N					X			
B11	N				X				
B12	N				X				
B13	Y	Hardcopy report submitted by employee for review.							
Count	**Y [4] N [9]**				**5**	**1**	**1**	**1**	**1**

Table B2c Near Miss Reporting Process

	Does the agency have a process to report near misses?		Reason(s) for not having a process for reporting near misses (Select all that apply)						
State	Yes/No	Description of near miss reporting process	Lack of resources	Fear of inconsistent reporting	Lack of clear definition of "near miss"	No clear value of near miss	No clear need in recording near miss incidents	Other	Unsure
C. State DOTs with $2-$4 billion in disbursements (2013)									
C1	N					X			
C2	N				X				
C3	Y	Near misses are reported in the same system used to report injuries and illnesses.							
C4	N								X
C5	Y	Near misses are reported in a Safety Incident System							
C6	N		X						
C7	Y	Employees complete a near miss report ɔrm. The report submittal and review rocess is the same as that for an injury.							
C8	Y	An incident report is filled out. The report includes a description of the actions taken to prevent the incident in the future							
C9	N							X	
C10	N							X	
Count	**Y [4] N [6]**		**1**		**1**	**1**		**2**	**1**

Table B2d Near Miss Reporting Process

	Does the agency have a process to report near misses?		Reason(s) for not having a process for reporting near misses (Select all that apply)						
State	Yes/No	Description of near miss reporting process	Lack of resources	Fear of inconsistent reporting	Lack of clear definition of "near miss"	No clear value of near miss	No clear need in recording near miss incidents	Other	Unsure
D. State DOTs with >$4 billion in disbursements (2013)									
D1	Y	The foreman on the site reports the incident to the county manager who then reports the incident to the district safety coordinator. The district safety coordinator completes an appropriate form and submits to the safety division. The safety division then reports the information via email to the executive staff. This process usually takes only a few hours from the initial report.							
D2	N		X						
D3	Y	Depends on the regional office. Some offices have a form that is completed. In some cases, a description of the incident is sent out to all employees who could be impacted by a similar event. A meeting with key participants and stakeholders is also held to review and discuss the incident.							
D4	Y	Simple written report with suggested actions submitted by employee.							
D5	Y	N/A							
D6	N				X				
D7	N		X						
D8	N								X
D9	Y	Description of the event is communicated via the phone to the safety office. A near miss form is also completed and submitted for review.							
Count	**Y [5] N [4]**		**2**		**1**				**1**

Table B3a Availability and Use of Health and Safety Data

State	Highway worker health and safety data: Available [A]? (Yes/No) / Used [U]? (Yes/No) / Completeness [C] if available (1 = very incomplete, 5 = very complete)																																
	Incident report			Police citation report			Worker insurance claim			Worker annual performance review			Worker safety training records			Contractor safety records			Injured worker medical record			Injury/ fatality data			Roadway design			Roadside design features			Other data		
	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C
A. State DOTs with <$1 billion in disbursements (2013)																																	
A1	Y	N	3	Y	Y	4	Y	N	1	Y	N	3	Y	Y	4	Y	Y	1	Y	N	1	Y	Y	5	Y	Y	4	Y	Y	4	N	N	
A2	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	N	N		Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	N	N	
A3	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	N	2	Y	N	4	Y	Y	4	Y	N	2	Y	N	2	N	N	
A4	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	4	N	N	
A5	Y	Y	4	Y	Y	3	Y	Y	3	N	N		Y	Y	4	N	N		N	N		Y	Y	5	N	N		N	N		N	N	
A6	Y	Y	4	Y	Y	3	N	N		N	N		Y	Y	4	Y	Y	4	N	N		Y	Y	4	Y	Y	4	Y	Y	4	N	N	
A7	Y	N	3	Y	N	3	Y	N	3	Y	N	3	Y	Y	3	N	N		Y	N	3	N	N		N	N		N	N		N	N	
A8	Y	N	1	Y	N	1	Y	N	1	Y	N	1	Y	N	1	Y	N	1	Y	N	1	Y	N	1	Y	N	1	Y	N	1	N	N	
A9	Y	Y	5	Y	Y	4	Y	Y	5	N	N		Y	Y	5	N	N		Y	N		N	N		Y	Y	5	Y	Y	5	N	N	
No. avail.	**9**			**9**			**8**			**6**			**9**			**5**			**7**			**7**			**7**			**7**			**0**		
No. used		**6**			**7**			**5**			**3**			**8**			**3**			**2**			**6**			**5**			**5**			**0**	
Avg.			**3.7**			**3.4**			**3.3**			**3.3**			**3.8**			**2.6**			**3.0**			**4.0**			**3.6**			**3.4**			
B. State DOTs with $1-$2 billion in disbursements (2013)																																	
B1	Y	Y	4	N	N		Y	Y	5	Y	N	3	Y	Y	4	N	N		Y	Y	2	Y	Y	4	Y	Y	3	Y	Y	3	N	N	
B2	Y	Y	5	Y	N		Y	Y	5	Y	Y	5	Y	Y	5	N	N		Y	Y	5	Y	Y	5	N	N		N	N		N	N	
B3	Y	Y	4	Y	N		Y	Y	4	Y	N		Y	Y	1	N	N		N	N		Y	Y	5	Y	N		Y	N		N	N	
B4	Y	Y	5	Y	Y	4	Y	N		Y	N		Y	Y	4	N	N		N	N		Y	Y	5	Y	N		Y	N		N	N	
B5	Y	Y	4	Y	Y	4	Y	Y	5	Y	N	4	Y	Y	4	Y	N	3	Y	Y	4	Y	Y	5	Y	N	3	Y	N	4	N	N	
B6	Y	Y	3	N	N		N	N		N	N		Y	Y		N	N		N	N		Y	Y	3	N	N		N	N		N	N	
B7	N	Y	4	Y	Y	3	Y	Y	4	N	N		Y	Y	3	Y	Y	2	Y	Y	3	Y	Y	3	Y	Y	4	Y	Y	4	N	N	
B8	Y	Y	3	Y	Y	3	N	N		Y	Y	4	Y	Y	4	Y	Y	4	N	N		Y	Y	3	N	N		N	N		N	N	
B9	N	N		Y	Y	5	Y	Y	5	N	Y		Y	Y	5	N	N		N	N		N	N		N	N		N	N		N	N	
B10	Y	Y	5	Y	Y	5	Y	Y	5	N	N		Y	Y	5	N	N		Y	Y	4	Y	Y	4	N	N		N	N		N	N	
B11	Y	Y	3	Y	Y	5	Y	Y	5	N	N		Y	Y	3	N	N		N	N		Y	Y	2	Y	Y	4	Y	Y	4	N	N	
B12	Y	Y	4	N	N		Y	Y	4	N	N		Y	Y	4	Y	Y	4	N	N		N	N		N	N		N	N		N	N	
B13	Y	Y	5	N	N		Y	Y	5	N	N		Y	Y	3	N	N		Y	Y	3	Y	Y	5	N	N		N	N		N	N	
No. avail.	**11**			**9**			**11**			**6**			**13**			**4**			**6**			**11**			**6**			**6**			**0**		
No. used		**12**			**7**			**10**			**3**			**13**			**3**			**6**			**11**			**3**			**3**			**0**	
Avg.			**4.1**			**4.1**			**4.7**			**4.0**			**3.8**			**3.3**			**3.5**			**4.0**			**3.5**			**3.8**			

Table B3b Availability and Use of Health and Safety Data

State	Highway worker health and safety data: Available [A]? (Yes/No) / Used [U]? (Yes/No) / Completeness [C] if available (1 = very incomplete, 5 = very complete)																														
	Incident report			Police citation report			Worker insurance claim			Worker annual performance review			Worker safety training records			Contractor safety records			Injured worker medical record			Injury/ fatality data			Roadway design			Roadside design features			Other data		
	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C	A	U	C
C. State DOTs with $2-$4 billion in disbursements (2013)																															
C1	N	N		N	N		Y	N		Y	N		Y	N		N	N		N	N		Y	N		N	N		N	N		N	N	
C2	Y	Y	4	Y	Y	3	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	3	Y	Y	4	Y	Y	4	Y	Y	4	N	N	
C3	Y	Y	5	Y	Y	5	N	N		N	N		Y	Y	3	N	N		N	N		N	N		N	N		N	N		N	N	
C4	Y	Y	5	Y	Y	3	N	N		N	Y		Y	Y	3	N	N		N	N		N	N		Y	Y	3	N	N		N	N	
C5	Y	Y	4	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	1	N	N		Y	Y	5	Y	Y	4	Y	Y	5	Y	Y	5	N	N	
C6	Y	N		Y	Y	2	Y	Y	4	N	N		Y	Y	3	N	N		Y	N		Y	Y	5	N	N		N	N		N	N	
C7	Y	Y	4	N	N		Y	Y	5	N	N		Y	Y	5	Y	Y	3	N	N		Y	Y	5	Y	N	5	Y	N	5	N	N	
C8	Y	Y	4	N	N		Y	Y	5	N	N		Y	Y	4	Y	Y	3	Y	Y	4	Y	Y	4	Y	Y	5	Y	Y	5	N	N	
C9	Y	Y	5	Y	Y	5	Y	Y	5	N	N		Y	Y	5	Y	N	3	N	N		Y	N		N	N		N	N		N	N	
C10	Y	Y	2	N	N		Y	Y	3	N	N		Y	Y	2	N	N		N	N		Y	Y	4	N	N		N	N		N	N	
No. avail.	**9**			**6**			**8**			**3**			**10**			**4**			**4**			**8**			**5**			**4**			**0**		
No. used		**8**			**6**			**7**			**3**			**9**			**3**			**3**			**6**			**4**			**3**			**0**	
Avg.			**4.1**			**3.8**			**4.4**			**4.5**			**3.3**			**3.3**			**4.0**			**4.3**			**4.4**			**4.8**			
D. State DOTs with >$4 billion in disbursements (2013)																															
D1	Y	Y	5	Y	Y	5	N	N		Y	N	4	Y	N	3	N	N		N	N		Y	N	5	Y	Y	5	Y	Y	5	N	N	
D2	N	N	4	N	N	4	N	N	3	N	N	3	N	N	4	N	N	1	N	N	3	N	N	4	N	N	5	N	N	5	N	N	
D3	Y	N	5	Y	N	5	Y	N	5	N	N		Y	N	3	N	N		N	N		Y	N	5	N	N		N	N		N	N	
D4	Y	Y	3	Y	Y	3	Y	Y	4	Y	N	4	Y	Y	4	N	N		Y	Y	2	Y	Y	4	Y	Y	4	Y	Y	4	N	N	
D5	Y	Y	3	Y	N	3	Y	N	3	N	N		Y	N	3	N	N		N	N		Y	Y	4	Y	Y	3	Y	Y	3	Y	Y	3
D6	Y	Y	4	Y	Y	3	Y	Y	3	N	N		Y	Y	4	Y	N	2	N	N		Y	Y	4	Y	Y	3	Y	Y	3	N	N	
D7	Y	N	4	Y	N	4	Y	Y	5	N	Y	3	Y	N	3	N	N		N	N		Y	N	3	Y	N	4	Y	N	4	N	N	
D8	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	Y	Y	4	N	N	
D9	Y	Y	5	Y	Y	5	Y	Y	5	Y	Y	4	Y	Y	5	Y	Y	3	N	N		Y	Y	3	Y	Y	5	N	N		N	N	
No. avail.	**8**			**8**			**7**			**4**			**8**			**3**			**2**			**8**			**7**			**6**			**1**		
No. used		**6**			**5**			**5**			**3**			**4**			**2**			**2**			**5**			**6**			**5**			**1**	
Avg.			**4.1**			**4.0**			**4.0**			**3.7**			**3.7**			**2.5**			**3.0**			**4.0**			**4.1**			**4.0**			**3.0**

Table B3c Summary of Availability and Use of Health and Safety Data

	Group A		Group B		Group C		Group D	
	<$1 billion in disbursements		$1-$2 billion in disbursements		$2-$4 billion in disbursements		>$4 billion in disbursements	
Average	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
No. available	6.7	75%	7.5	58%	5.5	55%	5.6	63%
No. used	4.5	51%	6.5	50%	4.7	47%	4.0	44%
Difference	2.2	24%	1.1	8%	0.8	8%	1.6	18%

Table B3d Average of All Completeness Metrics for All Health and Safety Data Types by Group

	Group A	Group B	Group C	Group D
	<$1 billion in disbursements	$1-$2 billion in disbursements	$2-$4 billion in disbursements	>$4 billion in disbursements
	Average across all data sources	Average across all data sources	Average across all data sources	Average across all data sources
Completeness across all data sources	3.4	3.9	4.1	3.6

Table B4a Time for Data Availability

	How long after an incident until the document/data becomes available for review and analysis? (months)										
State	Incident report	Police citation report	Worker insurance claim	Worker annual performance review	Worker safety training records	Contractor safety records	Injured worker medical record	Injury/ fatality data	Roadway design	Roadside design features	Other data
A. State DOTs with <$1 billion in disbursements (2013)											
A1	<1	<1	1-3	3-6	<1	3-6	6-12	<1	<1	<1	
A2	<1	<1	<1	<1	<1		<1	<1	<1	<1	
A3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
A4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
A5	<1	1-3	<1		<1			<1			
A6	<1	<1			<1	<1		1-3	<1	<1	
A7	>12	>12	>12	>12	>12		>12				
A8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
A9	<1	<1	<1		<1				<1	<1	
B. State DOTs with $1-$2 billion in disbursements (2013)											
B1	>12		>12	>12	>12		>12	>12	>12	>12	
B2	>12	>12	>12	>12	>12		>12	>12			
B3	<1	<1	<1	>12	<1			<1	<1	<1	
B4	1-3	<1	1-3		1-3			6-12			
B5	>12	>12	>12	6-12	>12	6-12	>12	>12	>12	>12	
B6	>12				>12			>12			
B7		6-12	1-3		3-6	3-6	3-6	>12	6-12	6-12	
B8	<1	<1		<1	<1	<1		<1			
B9		<1	1-3		<1						
B10	<1	<1	<1		<1		1-3	1-3			
B11	<1	<1	<1		<1			<1	<1	<1	
B12	1-3		<1		3-6	6-12					
B13	<1		<1		>12			<1			

Table B4b Time for Data Availability

	How long after an incident until the document/data becomes available for review and analysis? (months)										
State	Incident report	Police citation report	Worker insurance claim	Worker annual performance review	Worker safety training records	Contractor safety records	Injured worker medical record	Injury/ fatality data	Roadway design	Roadside design features	Other data
C. State DOTs with $2-$4 billion in disbursements (2013)											
C1					1-3			6-12			
C2	>12	>12	>12	>12	>12	>12	>12	>12	>12	>12	
C3	<1	<1			<1						
C4	<1	<1			<1				<1		
C5	<1	<1	<1	<1	<1		<1	<1	<1	<1	
C6	<1	<1	<1		<1		<1	<1			
C7	>12		>12		>12	>12		>12	>12	>12	
C8	<1		<1		<1	<1	<1	<1	<1	<1	
C9	<1	<1	<1		<1	<1		<1			
C10	>12		>12		>12			>12			
D. State DOTs with >$4 billion in disbursements (2013)											
D1	>12	>12		>12	>12			>12	>12	>12	
D2											
D3	>12	>12	>12		>12			>12			
D4	<1	<1	<1	<1	<1		<1	<1	<1	<1	
D5	>12				>12			<1	>12	>12	
D6	>12	>12	>12		>12			>12	>12	>12	
D7	<1	<1	<1		1-3			1-3	<1	<1	
D8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
D9	<1	<1	<1	<1	<1	<1		<1	<1		

Table B4c Summary Time for Data Availability

Group A			**Group B**			**Group C**			**Group D**		
<$1 billion in disbursements			$1-$2 billion in disbursements			$2-$4 billion in disbursements			>$4 billion in disbursements		
Time	Count	Percent	Time	Count	Percent	Time	Count	Percent	Time	Count	Percent
< 1 month	61	84%	< 1 month	31	39%	< 1 month	36	61%	< 1 month	33	57%
1-3 months	3	4%	1-3 months	8	10%	1-3 months	1	2%	1-3 months	2	3%
3-6 months	2	3%	3-6 months	4	5%	3-6 months	0	0%	3-6 months	0	0%
6-12 months	1	1%	6-12 months	7	9%	6-12 months	1	2%	6-12 months	0	0%
>12 months	6	8%	>12 months	29	37%	>12 months	21	36%	>12 months	23	40%

Table B5a Beneficial Data Sources

	Are there any worker health and safety data sources that would be beneficial to your agency which you currently do not have or do not have access to?	
State	Yes/No	If so, describe the data sources
A. State DOTs with <$1 billion in disbursements (2013)		
A1	N	
A2	N	
A3	N	
A4	Y	N/A
A5	N	
A6	N	
A7	N	
A8	N	
A9	N	
Count	**Y[1] N[9]**	
B. State DOTs with $1-$2 billion in disbursements (2013)		
B1	N	
B2	Y	N/A
B3	N	
B4		
B5	N	
B6	Y	An accident database with information about the types of vehicle crashes we are having with our equipment.
B7	N	
B8	Y	Database that will keep the records of the incidents involving the employees and a clear way to assess near misses.
B9	N	
B10	N	
B11	N	
B12	N	
B13	N	
Count	**Y[3] N[9]**	

Table B5b Beneficial Data Sources

	Are there any worker health and safety data sources that would be beneficial to your agency which you currently do not have or do not have access to?	
State	Yes/No	If so, describe the data sources
C. States DOTs with $2-$4 billion in disbursements (2013)		
C1	Y	In-agency Human Resources records
C2	N	
C3	Y	More detailed worker compensation data including lost and restricted time. This information is held by a separate state department.
C4	N	
C5	Y	N/A
C6	Y	National trends and data from other state DOT's.
C7	N	
C8	N	
C9	Y	Different types of summary reports on workers' compensation claims.
C10	N	
Count	**Y[5] N[5]**	
D. State DOTs with >$4 billion in disbursements (2013)		
D1	Y	Information from the state private road management companies and from our local municipalities.
D2	Y	N/A
D3	Y	OSHA inspection records for contractor work zones.
D4	N	
D5	Y	An integrated system of the various existing data sources.
D6	N	
D7	N	
D8	Y	An integrated safety data source where incidents can be analyzed across all available state health and safety databases.
D9	N	
Count	**Y[5] N[4]**	

Table B6a Use of Data for Agency Programs

	Has your agency used its own data or other data related to worker health and safety to develop any of the following policies/practices for highway workers in work sites on roadways?							
State	Additional training for workers	Additional training for supervisors	New standards for work site traffic control plans	Driver awareness programs	Worker behavior assessment programs	Safety incentive programs	Drug/alcohol abuse programs	Other
A. State DOTs with <$1 billion in disbursements (2013)								
A1	X	X		X	X		X	X
A2			X	X				
A3	X	X	X	X			X	
A4	X	X	X	X	X		X	
A5	X	X	X	X				
A6	X	X	X	X		X	X	
A7	X						X	
A8	X	X	X	X	X			
A9	X	X	X	X			X	
Count	**8**	**7**	**7**	**8**	**3**	**1**	**6**	**1**
Percent	**89%**	**78%**	**78%**	**89%**	**33%**	**11%**	**67%**	**11%**
B. State DOTs with $1-$2 billion in disbursements (2013)								
B1	X	X	X	X		X	X	
B2	X	X	X	X	X			
B3	X	X			X	X		
B4	X	X	X	X			X	X
B5	X	X						
B6	X	X		X	X	X		
B7	X	X	X	X	X			
B8	X	X	X	X			X	
B9	X	X	X	X			X	
B10	X			X				
B11	X	X						
B12	X		X	X			X	
B13	X	X	X		X			
Count	**13**	**11**	**8**	**9**	**5**	**3**	**5**	**1**
Percent	**100%**	**85%**	**62%**	**69%**	**38%**	**23%**	**38%**	**8%**

Table B6b Use of Data for Agency Programs

	Has your agency used its own data or other data related to worker health and safety to develop any of the following policies/practices for highway workers in work sites on roadways?							
State	Additional training for workers	Additional training for supervisors	New standards for work site traffic control plans	Driver awareness programs	Worker behavior assessment programs	Safety incentive programs	Drug/alcohol abuse programs	Other
C. State DOTs with $2-$4 billion in disbursements (2013)								
C1	X	X						X
C2	X	X	X	X	X	X	X	
C3	X	X	X					X
C4	X	X	X	X	X		X	
C5	X	X	X	X	X	X		
C6	X	X						
C7	X	X	X	X				
C8	X	X					X	
C9						X		
C10		X		X			X	
Count	**8**	**9**	**5**	**5**	**3**	**3**	**4**	**2**
Percent	**80%**	**90%**	**50%**	**50%**	**30%**	**30%**	**40%**	**20%**
D. State DOTs with >$4 billion in disbursements (2013)								
D1	X	X	X	X		X		
D2	X	X	X				X	
D3	X	X	X	X	X	X	X	
D4	X	X	X	X	X	X	X	
D5	X	X		X		X	X	X
D6	X	X	X	X				
D7	X							
D8	X	X	X					
D9	X	X	X	X				
Count	**9**	**8**	**7**	**6**	**2**	**4**	**4**	**1**
Percent	**100%**	**89%**	**78%**	**67%**	**22%**	**44%**	**44%**	**11%**

APPENDIX C INTERVIEW PROTOCOL

Worker Safety Interview Protocol
Last Updated: April 25, 2016

Concept:	Interview Question:	Probing Questions:
Introduction	Ask how the participant is doing. Introduce myself. State the purpose of the interview: "To follow-up on your responses to the survey and explore specific safety program/initiatives that have worked well in your state". We are enthusiastic to know everything about your experience with this topic in your state, so if I don't ask about particular element of your experience that you think may be of interest to us, please feel free to share those details with us. You can choose not to answer any of the questions and may stop the conversation at any time for any reason. Ask if it is okay to report the name of the state and details of their successful safety program/initiative in the final report. Ask if it is okay to record the conversation.	
Safety Program/initiative	In the survey response, you highlighted your agency having a particular safety program/initiative relating to _____ (varies by survey response). Could you elaborate on the details of that program/initiative? How long has your agency been using this particular program/initiative? Does this program/initiative only apply to agency employees (not contractor's and contractor's employees)? Do you collaborate with any other states on your safety program/initiatives? How has the program/initiative affected: • Highway worker safety? • Highway worker behavior? Do you feel that the program/initiative has been a success, and why?	Is the program/initiative data driven (in terms of either the development of the program or the continued implementation of the program)? Is the program/initiative still in its early phases or is it well established? Is there documentation that describes the program and, if so, could we get a copy to include in our report? What were some of the challenges in implementation? If no, have you had good compliance with the program/initiative from contractors? If yes, which states and how long have you been collaborating?

		Have there been impacts to other agency goals such as quality, productivity, cost, etc.? Are there any changes that you would make to the program/initiative to make it more successful? What would you recommend to other states that want to implement a similar program/initiative?
Research Used	Did your agency use any research when implementing this program/initiative? Were other agencies or organizations involved when the program/initiative was implemented or adjusted?	Was the research conducted Internally? Was the research conducted Externally? Could you provide examples of the research? Did those agencies include: • Law enforcement? • Other states? • Construction divisions? • Traffic divisions? • Contractors? • Insurance providers?
Data Used	What data sources does this program/initiative use? Were these data sources available to the agency before the implementation of this program/initiative?	Are these data sources internal? What data is used from these sources, and how is it used? Was that data source cleaned or re-organized for this program? Was that data source previously collected by the agency?
Program Process	Does the program/initiative use a reporting processes or common forms?	If yes, would you be willing to provide that documentation to be included in the report? If preferred, state identifying and other information can be removed.

Participants	What personnel/offices within your agency are involved with implementing the program/initiative? Which office within your agency has responsibility for the program/initiative?	How is the program/initiative communicated to the participants? Is training provided?
Evaluation	What metrics are you using to evaluate the effectiveness of your safety program/initiative?	Is the agency doing the analysis or a vendor? Are reductions in incidents or costs being considered?
Agency Perspectives	What is your agency's leadership's view of this safety program? What are regional and local agency perspectives of this safety program?	Is the leadership maintaining support for the program/initiative? Are the compliance levels high?
Conclusion	Are there any other aspects of the safety program/initiative that you feel are important that were not covered in our conversation? "Thank You very much for your time" **Stop Recorder**	